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ILLUSTRIOUS PHILOSOPHERS OF A BYGONE ERA.

THE DAWN OF A BRILLIANT ERA.

By JOHN MILLS, F.R.A.S., in Knowledge.

"Not in vain the distance beacons. Forward, forward, let us range;
Let the great world spin for ever down the ringing grooves of change."

THE year upon which we have just entered completes the sixth decade of Queen Victoria's reign—a reign which for fullness of time, virtuous and enlightened policy, and glorious conquest in the arts of peace, has no parallel in the annals of this realm. Could one but draw true word pictures of social England as it was in the year 1837 and as it is to-day, after the lapse of sixty years—years teeming with the fruits of genius in every walk of life—the contrast between the two periods would form a convincing proof of the intellectual development and the amplification of the resources of the people—advantages won by a bloodless victory of mind over matter. Yet there is in reality no gulf between the past and the present. The men whose doings have laid the foundation of our commercial prosperity belong to a past age, and we who carry on the appointed work of improvement and civilization are their progeny and belong emphatically to past times. Theirs was the understanding at once penetrating and vigilant, but more distinguished, perhaps, for the caution and sureness of its march than for the brilliancy or rapidity of its movements.

It is our object in this short sketch to convey some idea of the condition of science when the Queen ascended the throne in 1837. Other papers will follow dealing with the development of the several branches of science during the past sixty years. The mind of man in its progress toward its higher destiny is confronted, in the main, with the physical earth as a problem which, within the limits of a life, it must struggle to solve. The intellectual spirit is capable of embracing all finite things. Science alone can interpret their mysterious whispers. It requires an effort of the imagination to the great bulk of people now living to realize what the condition of life must have been in 1837. Divested of the luxuries which science has heaped upon us since that auspicious epoch, we should relapse into a state of civilization which would more nearly resemble that of ancient Greece and Rome than that to which we have attained at the present time.

One of the factors too important to ignore in the grand sum of scientific progress during the unique reign of our gracious sovereign lady is the Royal Institution, which was founded in the year 1800. "Its aim and objects were to diffuse the knowledge and facilitate the general introduction of useful mechanical inventions and improvements, and to teach by philosophical lectures and experiments the application of science to the useful purposes of life." Count Rumford, to his lasting credit be it said, was the chief promoter of this temple of science, which can boast of having given in its early days employment to Young, Davy, Brande, and Faraday. This institution may, with some regard for truth, be looked upon as the nursery in which the plants that have yielded so much fruit in their maturer years were tended in their infancy. By whom? By men who were our progenitors in science—patient, indomitable, calmly and wisely bold, modestly self-reliant, ever watching, ever toiling, ever adding to the store of knowledge that was to benefit not them alone, but the great human race; each guided by his own perceptions of what is great in humanity and fitting in a nation—men whose instinct it was to work for the world and fight against misery.

About the year 1837 what has been called the "old astronomy" may be said to have culminated. The elder Herschel, almost equally famous as optician and astronomer, had, so to speak, put on the coping stones of the fabric. His magnificent speculations on the Milky Way, the constitution of nebulæ, etc., first opened the way to the conception that what was called the universe was in all probability but a detached and minute portion of that fathomless series of similar formations which ought to bear the name. In a word, he assigned to the earth its true position—an ignoble one—among the vast array of worlds revolving in the depths of infinitude; made clear to the thoughtful student of nature that the vastness of created worlds extends beyond the confines of imagination; that the phenomena of reality are more startling than the phantoms of the ideal. It is true that the younger Herschel, who continued the labors of his illustrious father, made some experiments in spectrum analysis as early as the year 1835; and Niepce, in 1824, by fixing images produced by the camera obscura, invented photography; but the part which these two branches of science were to play in the "new astronomy" was not so much as conceived at the commencement of the present reign. That the prism should be the touchstone of worlds, the markings in the spectra of celestial bodies telling the story of the composition of these denizens of outer space with something like the precision with which a jeweler determines the quality of gold by comparing its color with the markings of specimens of known quality on the touchstone, is a chapter in the romance of science which belongs to the Victorian era; as is also the part played by photography in revealing the existence of stellar and nebular systems far beyond the reach of telescopic and spectroscopic power, and its useful application to Doppler's principle as regards the speed and direction of the motion of stars.

In the domain of geology, a great awakening to a true knowledge of the history of our planet had been effected in the early part of the century by the teachings of William Smith, the "father of English geology," Agassiz, Murchison, and others. In February, 1831, the Geological Society, which had hitherto passed him over with a sort of silent contempt, was at length roused to an impartial estimate of Smith, which resulted in the passing of a resolution—"That the first Wollaston medal be given to Mr. William Smith in consideration of his being a great original discoverer in English geology, and especially for his having been the first in this country to discover and to teach the identification of strata, and to determine their succession by means of their embedded fossils." This shrewd observer pointed out that rocks were deposited in successive order, and thus carried the doctrine of evolution into the domain of geology; and he proved that whatever stratum was found in any part of England, the same remains would be found in it and no other. Agassiz, about the same period, was working out his theory of glaciers, great bowlder deposits, striation of rocks and so on. These results, combined with those of other contemporary workers, were slowly but surely producing a great transformation in the minds of thinking men. The universal belief in a six thousand year period as the age of the world had started on its retrograde course into dim antiquity, to which all the light of subsequent discovery can assign no limit. But to the great mass of the people, at the time of which we write, all this was a vast ignorance.

Popular opinion of that time (1837) was almost uniform in favor of the belief that all living things left the hands of the Creator just as we now see them. That environment—variations dependent upon food, climate, habitat, and other conditions—had anything to do with the form, size, or color of an animal, or that insects had any connection with the scent, color and

FIG. 1.—FARADAY'S TUBE FOR LIQUEFYING CHLORINE, ETC.

form of flowers, was a plane of thought too elevated for the circumscribed understanding of the masses of that day. But the little leaven which has in the interim transformed the whole lump had begun to operate. John Hunter had pointed out the necessity of embracing and connecting all the studies relating to life, instead of limiting the science of biology to the study of simple forms through anatomy and physiology only. He raised surgery from a poor empirical art to a noble science, and founded the Hunterian Museum, where the organs of the animal body are displayed in all their morphological aspects. His illustrious pupil, Jenner, had displayed unrivaled skill in minute dissections and delicate injections, and by the practice of vaccination bequeathed to the whole civilized world a preventive for a disease the ravages of which formed one of the most terrible scourges to which the human race was ever subject. Erasmus Darwin (the grandfather of the greater Darwin) had foreshadowed the theory of evolution in these words: "When we revolve in our minds the great similarity of structure which obtains in all the warm blooded animals, mankind included, one is led to conclude that they have alike been produced from a similar living filament." Von Baer had, in 1828, shown that the embryo of a fish, a lizard, a bird, and an ox are not distinguishable from one another, and continue growing so until a certain stage, when their characteristic forms become apparent. Animals could, therefore, be differentiated according to the special characters they assume from the beginning.

Geoffrey St. Hilaire had demonstrated the unity of plan of the animal kingdom, and was one of those who believed all species to be derived by modification from primitive types. Sir Joseph Banks brought much influence to bear on the progress of science by diffusing the products of other climates over each portion of the globe. He brought into Europe the seeds of the South Sea Islands, having previously distributed to the latter

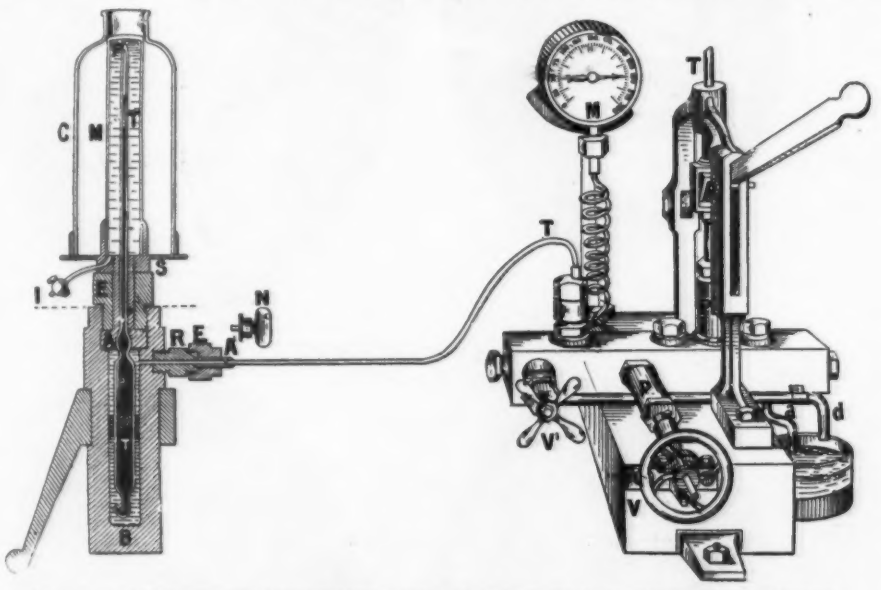


FIG. 2.—CAILLETET'S APPARATUS FOR LIQUEFYING OXYGEN AND OTHER SO-CALLED PERMANENT GASES.

those of Europe. But although evolution was then in what may be called the incipient stage, it remained to be proved and worked out in detail by the classic researches of Darwin.

Most of the chemical elements were discovered before the year 1837. Five elements were discovered from the year 1839 to 1844, and five others were subsequently added after the general introduction of spectrum analysis. Dalton, in 1808, published the first volume of his new system of chemical philosophy, in which he placed the atomic theory on a firm basis, and established once for all the law of multiple proportions. Before Dalton's time chemistry consisted of a heterogeneous mass of separate facts. The truth that chemical union between dissimilar bodies will only take place in absolutely unalterable proportions, as distinct from mechanical mixtures, is as imposing in grandeur as the law of gravitation itself. To follow the bearings of this great discovery in chemical science would be to reveal all the operations of the analytical chemist, and to exhibit the disparity between a scientific chemical manufacturer and the rule-of-thumb operator. By the promulgation of Dalton's views chemistry became for the first time an exact science. Davy had laid down the laws of electro-chemical decomposition, and by their application discovered metals of the alkalies and alkaline earths; while in 1816 he bequeathed to the mining world his safety lamp, which has served the double purpose of preserving life and increasing commerce. In 1828 Wohler broke down the barrier which was long supposed to exist between inorganic and organic substances. It was thought that organic substances could only be produced in the living bodies of plants and animals requiring for their construction not only chemical affinities, but a supposed vital force. But Wohler opened the way to a new field of scientific investigation by producing urea synthetically—that is, by building it up from its inorganic constituents. Allen had proved the identity of the diamond with charcoal: while quite recently, it may be mentioned, Moissan has accomplished the extraordinary feat of transforming carbon from the amorphous to the crystalline condition—that is to say, he has succeeded in making diamonds artificially.

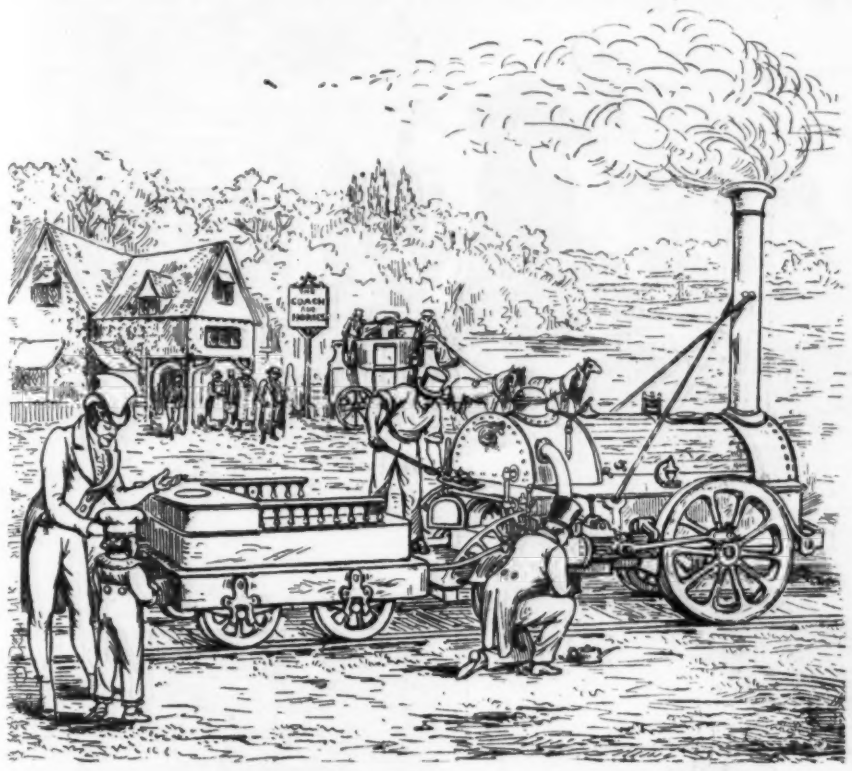
About the year 1837 electric telegraphs were first established as commercial speculations in three different countries. Steinheil's system was carried out at Munich, Morse's in America, and Wheatstone and Cooke's in England. The wires were buried in the earth, and were five in number, each acting on separate needles, the first telegraph line being on the Great Western Railway from Paddington to West Drayton. These initial attempts at telegraphy, clumsy enough when compared with the refined methods of our own time, were inspired chiefly by the work of Faraday, who established the connection between magnetic and electric currents; though Oersted, Ampere, and Schweizzer, by their respective discoveries of the deflection of a magnetic needle by an electric current, the foundation of electro-dynamics, and the electric coil, come in for a share of the credit; while Sturgeon, who constructed the first electro-magnet, should not be forgotten. Faraday, prior to the Victorian era, had succeeded in converting gases into liquids by subjecting them to pressure in sealed tubes, and thus led the way in that series of grand experiments which later, in the hands of Cailletet and Pictet, were to prove that there is no such thing as a permanent gas.

In the domain of invention or mechanical science the contrast between the present time and the year 1837 is most striking. Sixty years ago the great railways were all begun, but not one of them was completed. The line between Liverpool and Manchester was opened in September, 1830. In 1836 it was carrying four hundred and fifty thousand passengers in the year. There were also a great many lines projected, which afterward settled down into the present great trunk lines. At that time a writer in the Athenæum says: "When these lines are completed, letters and passengers will be conveyed from Liverpool to London in ten hours. Little attention has yet been given to calculate the effects which must result from the establishment throughout the kingdom of great lines of intercourse traversed at a speed of twenty miles an hour." There were no Hansom cabs and no parcels delivery company. There was a twopenny post, but no penny post and no book post. It was not till 1838 that the Sirius and Great Western first steamed across the Atlantic. In the main, however, there was no means of transporting man, merchandise, or message quicker than a horse could take them. The result was an isolation of town from town, and of the country from London, which made between the England of that day and the England of our own time a difference which will be appreciated by all. There was no single daily newspaper published outside London. It was a society unfurnished with these things that Queen Victoria began to rule over in 1837. The electric telegraph, making as it now does the whole civilized world all of a piece, through which it ramifies like a vast nervous system, had not then linked the sovereign with every part of her dominions. America and Australia were then practically unknown to the bulk of our people. In short, the nineteenth century actually began with steam communication by sea, with steam machinery, with railways, with telegraphs, with the development of the colonies; but all these transforming influences were in reality nothing more than

the dawning of the brillant Victorian era, which has made its indelible imprints on the scroll of history.

The men portrayed on the plate accompanying this article are representatives of the philosophers of the latter part of the eighteenth and the first half of the nineteenth centuries, who, by the impetus they gave to science, prepared the way for those grand generalizations which have lent to the Victorian era such a glorious halo. John Dalton was born at Manchester of a Quaker family, and the chief work of his life was a clear enunciation of the theory of atoms—known as the atomic theory. Sir Humphry Davy hailed from Cornwall, and while still very young discovered nitrous oxide (laughing gas), which led to his appointment as the first professor of chemistry in the Royal Institution. Michael Faraday, as Davy's assistant, exhibited great ingenuity, which ultimately led to his appointment as his chief's successor. His discovery of the production of an electric current by the rotation of a magnet has led to many applications of electricity. Sir Joseph Banks was a man of private means, and went round the world, as botanist, with Captain Cook, in the years 1768-1771. He bequeathed his valuable library and herbarium to the British Museum. James Watt, born in Greenock, became a mathematical instrument maker in London, but his chief work was the improvements which he introduced in the construction of the steam engine.

Sir William Herschel, born at Hanover, came to England in 1757. He was by profession a musician, being organist at Halifax parish church at one time and at the Octagon Chapel, Bath, at another. But, later, astronomy attracted his attention, and, after making his own telescope, he discovered the planet Uranus in 1781. John Hunter, born at Long Calderwood, was the greatest anatomist and surgeon of his time. At his death 10,563 specimens and preparations illustrative of anatomy, physiology, pathology, and natural history were found in his museum. Edward



GEORGE STEPHENSON'S ROCKET (1829), THE FORERUNNER OF THE MODERN LOCOMOTIVE ENGINE.

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Jenner, Hunter's pupil, was born at Berkeley, in Gloucestershire. He was first led to study vaccination by hearing a countrywoman remark that she could not take the smallpox because she had had the cowpox.

ON THE FLOATING OF METALS AND GLASS ON WATER AND OTHER LIQUIDS.*

DURING the progress of a research on the surface tension of liquids, and on the tension of films, I observed that rings of aluminum, made of wires of various diameters, floated on water when these rings were chemically clean. A ring 62 millimeters in diameter, made of aluminum rod 3·6 millimeters (⅛ inch) in thickness and weighing 5·6 grammes, floats on water, sometimes for several minutes, sometimes for several hours, the duration of flotation depending on conditions to be stated in a subsequent publication.

I naturally thought that these remarkable phenomena were peculiar to aluminum, because in all the works on physics I have read it is stated that to float a metal on water it is necessary that its surface should previously be greased. (See the latest treatise on physics, by Violle; vol. i, pt. 2, p. 679.) I found, however, that all metals, from platinum, of a density of 22, to magnesium, of a density of 1·7, float on water when their surfaces are chemically clean.

Rings were made of aluminum, iron, tin, copper, brass and German silver. The wire of these rings is one millimeter thick and the rings are about 50 millimeters in diameter. The axis of the wire of a ring is in a plane, in other words, the rings are flat. Each of these rings has soldered to it a thin wire along a diameter and raised above the plane of the ring. On this wire is cemented a platform of thin metal. These rings are highly polished and are chemically clean.

On loading one of these floating rings, by gradually adding weights on its platform, the ring sinks deeper and below the general surface of the water, till, finally, it breaks through the depressed surface. On the form of this depressed surface (which I have plotted) depends the amount of weight per centimeter of circumference of the ring required for the ring to break through the surface of the water. This weight, in the cases of the rings mentioned, is, on the average, 0·135 gramme per centimeter, or about double the surface tension of water, because tangents to the depressed surface of the water, at the point where the rupture occurs, are vertical.

In the present stage of the research I am inclined to hold the opinion that the flotation of metals and of glass depends on a film of air which is condensed on their surfaces. The following experiments seem to sustain this opinion. If a ring made of platinum wire ⅛ millimeter thick, which readily floats on water, is heated to redness and as soon as cold is placed on water, it sinks. Also, when withdrawn from the water and wiped dry, it again sinks when placed on the water, but after the same dried ring remains about a quarter of an hour exposed to the air, then it will float. If the platinum ring, after having been heated to redness, remains in the air about a half hour and then is placed on the water, it floats.

Glass behaves in a similar manner to platinum. If a rod of glass, recently drawn out in a spirit flame and just cold, is placed on water, it sinks. After a freshly made rod has remained exposed to the air about a quarter of an hour, it will float. If a recently made glass rod which has just sunk in water be withdrawn, wiped dry and exposed to the air for a quarter of an hour, it will float. The glass rods used in these experiments are one millimeter thick and four to five centimeters long.

Under certain conditions the ratio of the weights required to make a platinum ring break through the surface of water and through the surface of another liquid is the ratio of the surface tension of water and that of the liquid. The ratio is 1 : 1·09 in the case of water and a solution of chloride of sodium of density 1·2. Taking 0·077 as the surface tension of water, we have 1 : 1·09 = 0·077 : 0·0849. Platinum is used for such experiments because it is not oxidizable and is chemically inert to nearly all liquids.

The relation that the experiments mentioned in this article have to the surface tension of water and other liquids, and to the change of surface tension on the exposure of a liquid to the air, will be discussed in a paper containing a fuller account of facts and theory than can be given in this notice.—By Prof. Alfred M. Mayer.

* From Science.

THE DAVY-FARADAY RESEARCH LABORATORY.

IN Albemarle Street, London, adjoining the imposing facade of the Royal Institution, is an old fashioned mansion, which was once the residence of Lord Cowley. Like most of these West End residences that antedate Nash and the age of stucco, its lofty rooms and handsome staircase recall the spacious hospitality of bygone days when Albemarle Street was very "West" indeed and fashionable society groped its way home by aid of the linkboy's fitful torch. But it will henceforth subserve the genial purposes of hospitality no more. Peering through the deep Queen Anne windows to-day, you will see without difficulty that in some way or other science has set her seal on it. The walls have lost their somber paneling and gleam with the cleanest of white tiles. You get a glimpse of long, severe teak tables, fitted up with curious metal taps, glass vessels with crooked necks, rows of Bunsen burners, and a miscellaneous population of professional looking stoppered bottles. No. 20 Albemarle Street, in fact, looks like a branch of the Royal Institution next door, only more so. The explanation is that what was Lord Cowley's town house is now an important national institution—the Davy-Faraday Research Laboratory, to wit—founded and endowed by that generous and enthusiastic man of science Dr. Ludwig Mond, F.R.S. It will be practically the first great public laboratory ever established in England purely for the purposes of chemical and physical research. Dr. Mond has lavished money on the alterations, fittings, apparatus and appliances required to convert this roomy old building into a place where the patient and delicate work of scientific exploration may be fitly carried on, and he has crowned all with a splendid endowment to meet its heavy working expenses. The Royal Institution next door is to act as a sort of godfather and guardian to the Davy-Faraday Laboratory, but otherwise it is to remain an entirely independent institution. The keynote of Dr. Mond's public spirited scheme for the advancement of science is simple. The laboratory, with its splendid equipment, is open as a free workshop to every man of science who wishes to enter the field of pure research and can show the trustees that he is the right man for the work.

Externally there are only trivial signs of the splendid accommodation that Dr. Mond has provided inside No. 20 Albemarle Street for the men of research. A London Daily Graphic representative who recently went over the laboratory found that the numerous spacious rooms extending from the basement to the fourth floor had all been admirably utilized. No fewer than sixteen separate laboratories for research work, each capable of accommodating one or more investigators with their assistants, have been provided, besides a large museum of apparatus and various rooms for special experiments. It is interesting to note how the specialisms into which all scientific research tends to divide itself appear to have been provided for. On the ground floor, for instance, is a fine room specially fitted for the delicate work of organic chemistry—that progressive branch which has given us the myriad useful products of coal tar and has the loftiest aims, perhaps, of all. You can see in all the beautiful fittings and apparatus the experience which Dr. Mond has borrowed from the great German laboratories.

At the rear of this is an equally fine room for "inorganic" research, and between the two a balance room, where the subtile compounds under treatment by the chemists are weighed down to the tiniest fraction of a grain. Solidly bedded on masses of stone projecting from the walls, nothing short of an earth wave would give them a tremor. When you are weighing to the 5,000th part of a grain, you require precautions of this sort.

On this same ground floor is a useful little ironclad den. This is the explosion room, and the post of observation is at a small hole in the iron door. Down in the basement are rooms for thermo and pyro-chemistry. The latter means research with the all-conquering electric furnace. Great batteries of electrical accumulators are to be found here, and deep down below the level of Albemarle Street we find Lord Cowley's wine cave converted to the nobler uses of a "constant temperature" vault. A beautiful room is the museum of apparatus on the second floor, where everything will awe and bewilder the layman. For here are stored all the fearful and wonderful tools with which the researchers will work. It is a blaze of glass and brass. By the time the visitor has got up to the third floor he gets bewildered with the apparently endless succession of handsome workrooms, all splendidly fitted with teak operating tables, glazed fume chambers, slate reagent racks, gas furnaces, blowpipe stands, stoneware sinks, and what not. On the fourth floor it is still the same, varied by a dark room for electric discharge observations, and another absolutely black for photographic work. Even the roof comes in; the eternal red gas and blue water pipes which crawl about everywhere are found writhing up here. In a word, this is a place where the chemist can be happy. It is kept at the even standard chemical temperature (62 deg. Fahrenheit) throughout by steam radiators, and there is a lift reaching every floor.

Dr. Mond has not only furnished the laboratory with the most modern instruments and appliances for researches in pure and physical chemistry, but has also given an ample endowment, so that the laboratory may be maintained in a state of thorough efficiency, his object being to give every assistance and encouragement, within the limits of the endowments, to scientific workers. To accomplish this has cost a hundred thousand pounds, of which sum £38,000 is sunk in the building and its equipment, while the remaining £62,000 constitutes the endowment fund. For the very practical way in which Dr. Mond has shown his interest in the promotion of material knowledge, men of science cannot express too warm a sense of gratitude. The scientific world looks to the workers in the laboratory to repay the generosity of the founder by their contributions to knowledge, and so induce other benefactors to follow the example set by Dr. Mond.

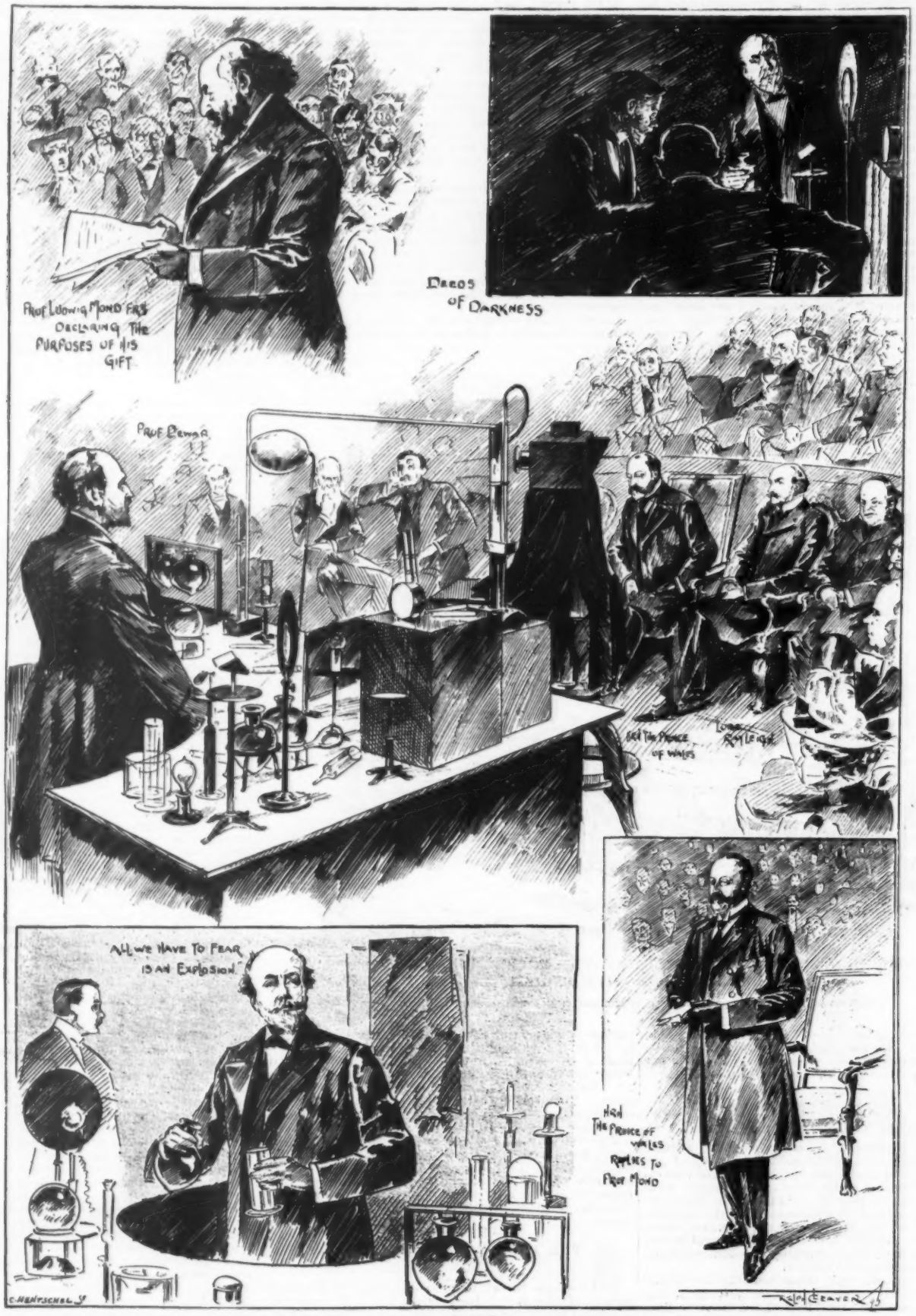
The following account of the opening of the laboratory, abridged from the report in the Times, will be read with interest:

Dr. Mond, addressing the Prince of Wales, said that under the auspices of his royal highness' august father, whose enlightened mind had fully realized that the pursuit of pure science was the most potent factor in the promotion of the intellectual as well as the material progress of this or any other nation or of humanity at large, a movement was set on foot fifty years ago to found an institute for the pursuit of pure chemistry, which was not only to give practical and systematic instruction to students, but was also to provide a place where original research could be conducted by fully qualified investigators. At first it was proposed to attach this institute to the Royal Institution. The eminent professors of the time, Faraday and Brande, expressed their strong approval of the intended project, and their desire that it might be carried out at the Royal Institution, if it could be done well; but, nevertheless, this idea had to be abandoned, because sufficient accommodation could not be found within the precincts of the institution. The first part of the scheme was carried out a few years later by the foundation of the Royal College of Chemistry, which, under the guidance of the illustrious Hofmann, soon became one of the most successful schools of chemistry in the world; but the second part, that of providing a place

where original researches could be carried on by a number of independent investigators, had been waiting all this time for its realization.

Several years before these facts came to his knowledge he had determined of his own accord to found in London a laboratory of research in purely scientific chemistry and in physical chemistry, that borderland between chemistry and physics from which, in his opinion, they might hope to learn more about the real nature of things than from any other branch of natural science. He also had come to the conclusion that such they readily accepted with unanimity. Work was immediately commenced to alter the building so as to make it suitable for its new purpose, and, thanks to the advice which had been freely extended to him by scientific men all over the world and the active co-operation of Lord Rayleigh and Prof. Dewar, of the architect, Mr. Flockhart, and of his son, Mr. Robert Mond, to whom he left the selection of the apparatus and the equipment of the place generally, the laboratory which they asked his royal highness to inaugurate that day would stand favorable comparison with any other laboratory in or out of England as to the completeness and convenience of its appliances, and was provided with the best instruments made at the present day. It was unique of its kind, being the only public laboratory in the world solely devoted to research in pure science.

In order to insure its continued usefulness, he had endowed it so as to cover the cost of maintenance of the fabric and all necessary current expenses. He named it the Davy-Faraday Research Laboratory in perpetual memory of those two great pioneers of science who carried out their world famed and epoch making researches almost on that spot, and whose example he hoped would stimulate and inspire every one who came to work under that roof. It was a source of very great gratification to him that the eminent successors of those great men, Lord Rayleigh and Prof. Dewar, had consented to undertake the duties of directors of the laboratory, and this gratification had been the greater because those gentlemen made it a condition of their acceptance of the post that it should be without emolument. An experienced superintendent had been appointed in the person of Dr. Scott, and nothing was now wanting for its success but a number of investiga-


PROF LUDWIG MOND F.R.S. DECLARING THE PURPOSES OF HIS GIFT
DEEDS OF DARKNESS
PROF DEWAR
H.R.H. THE PRINCE OF WALES
LORD RAYLEIGH
ALL WE HAVE TO FEAR IS AN EXPLOSION
H.R.H. THE PRINCE OF WALES REPLIES TO PROF MOND

THE PRINCE OF WALES OPENING THE DAVY-FARADAY RESEARCH LABORATORY, ADJOINING THE ROYAL INSTITUTION, LONDON.

a laboratory would derive the greatest advantage if it could be associated with the Royal Institution of Great Britain, which had during its long existence made the promotion of original research in these sciences one of its main objects, and the laboratories of which had been productive and were still productive of such marvelous results at the hands of the eminent professors elected by the institution. He therefore gladly embraced the opportunity which recently presented itself of acquiring the commodious house immediately adjoining the Royal Institution, and submitted a scheme to its managers which met with their fullest sympathy and which

tors competent and ardent to continue the great work of this century, the unraveling of the secrets of nature. As soon as his royal highness had declared the building open, persons of either sex or any nationality would be welcome within its walls who could satisfy the laboratory committee that they were fully qualified to undertake original scientific research in pure and physical chemistry, and preference would naturally be given to those who had already published original work. If this country had distinguished itself in one way more than another in that glorious rivalry with other nations for extending our knowledge of natural

phenomena and our power over the forces of nature, it had been by the large number of contributors to our knowledge who on the Continent would be called amateurs in science—men who devoted their lives to the study and advancement of science from pure love for the subject. He need only instance the names of Cavendish, Joule, and Darwin to say that they included men of the very highest rank.

In giving this laboratory to the English nation he had done so in the firm conviction that this country would continue to bring forth in the future, as it had done in the past, men of the same rank and of the same devotion to science for its own sake, and it was a fond hope of his that such men would find there all the facilities and all the necessary appliances for carrying out their researches. The further we advanced in the study of nature, the more accurate and elaborate was the apparatus required, and the more difficult it became to carry on delicate work in a private laboratory. He had placed that laboratory in the center of London, because he believed that this great city would continue to be the intellectual center of the civilized world, where the brightest minds would congregate. He had intrusted it to the Royal Institution so as to insure its being open to men and women of all schools and of all views on scientific questions. It had given him great pleasure that in establishing the Davy-Faraday Laboratory, he had been able at the same time to enlarge the old laboratories of the Royal Institution, and also to make additions to its library and reception rooms, which he hoped would prove a convenience to its members. He looked upon that laboratory as an important step forward in that great movement for the advancement of scientific research in this country to which his royal highness' revered and illustrious father gave so powerful an impulse, and which has been so distinguished a feature of the many-sided and unparalleled progress made by this nation during the glorious reign of his mother, Her Majesty the Queen. It was a source of specially great satisfaction to him that his royal highness deemed that laboratory worthy to be opened by himself, and he humbly thanked his royal highness for having come there that day. His presence on that occasion would certainly add very greatly to the success of the Davy-Faraday Research Laboratory of the Royal Institution.

The Prince of Wales, in reply, said: "Prof. Mond, it affords me much satisfaction to assist at the opening of the series of beautifully arranged and well equipped research laboratories which this country owes to your generosity, and I congratulate the members of the Royal Institution of Great Britain upon this most important accession to the resources which have been placed at the command of the institution for the advancement of chemical and physical science. The Royal Institution has long enjoyed a world wide reputation, thanks to the marvelous work of the succession of illustrious men whose researches, carried on within these walls, have very largely contributed to secure and maintain for this country a foremost position as a source of great discoveries and important advances in science and its applications. The identification of the laboratories which you have founded with the names of two of the most eminent of former professors of the Royal Institution and of English men of science—Humphry Davy and Michael Faraday—is a graceful act on your part. The fact that the present distinguished professors of physics and chemistry, Lord Rayleigh and Prof. Dewar, have undertaken the important duties of directors of the new research laboratories without any remuneration must afford most gratifying evidence to you of the great faith entertained by them in the benefit to the promotion of science which your wisely applied munificence is destined to realize." His royal highness then declared the laboratory open. We are indebted to the Illustrated London News for our engravings.

MIND IN ALL ANIMAL LIFE.

By DANIEL ALLYN GORTON, in New York Medical Times.

THE close observer may find in all the kingdoms of nature—the mineral, vegetable, and animal—indubitable evidence of the existence of mind, or a psychical principle, animating each, and working out in each a definite idea and purpose. This psychic principle is not confined to nerve substance or even to protoplasm. But let us confine our observations to the animal kingdom, and begin with the lowest form of organic substance—protoplasm. This shows sensibility to the light, and, like plants, will make voluntary efforts to get itself into the light. The polype knows the difference between living and dead infusoria, and manifests aggressiveness in seeking nutriment; that is, it will contend with other polypes. Von Hartmann says that, if living infusoria be placed in water within a few lines of the polype, "the latter perceives it—God only knows how—and produces a whirlpool with his arms in order to draw it within its grasp. On the other hand, should dead infusoria, a small vegetable organism, or a particle of dust, approach quite as close, it does not trouble itself at all about it."

Spiders throw off injured legs, and regenerate them. So do crabs. Fishes likewise regenerate their fins, lizards their tails. The asterias reproduce their rays. So do snails and beetles their injured and lost antennæ and tentacles. Pigeons, according to Voit, have been known to regenerate their destroyed cerebrum, together with its function. Birds renew lost feathers, fishes their injured scales, and frogs their broken legs. "Spallanzani saw among salamanders the four legs, with their ninety-eight bones, besides the tail, with its vertebræ, reproduced six times within three months. In others the lower jaw, with all its muscles, vessels and teeth, was regenerated." The eye, in this species, according to Blumenbach, has been known to reproduce itself when the optic nerve escaped injury and a part of the membranes of the eye remained intact. Would any one dare to deny that these marvels of conservation and repair are due to psychic power?

The ant is supplied, of course, with the rudiments of a nervous system; but it is totally devoid of a cerebrum, and, therefore, of an organ of consciousness. Nevertheless, it exhibits many of the psychical powers of man, such as building a place of refuge, providing homes, food, protection against enemies, making war, holding slaves, having caste distinctions, etc. They exhibit remarkable sagacity in treating their wounded, as to the wounded extraordinary powers of recovering from wounds. Latville cut the antennæ of an ant, whereupon other ants came and covered the wound with a viscid fluid, secreted in their mouths. Moreover, ants make use of ambulances in carrying off their wounded in battle, and were probably the first to invent that contrivance for transferring the wounded. According to Pierre Huber, an authority on this subject, vouched for by Darwin, the habits of the various species of ants differ greatly, as likewise do the habits of members of the same species. Some species make the female do the work. In others, the burdens of life are borne by the males. Some species are warlike, others peaceful. Some species are slave holding, and live in genteel leisure, making their slaves do the toiling; while others work with their slaves. Other species do not indulge in slave holding, but do their own work. "In Switzerland," says Darwin, "the slaves and masters work together, making and bringing materials for their nests. Both, but chiefly the slaves, tend and milk, as it may be called, their aphides; and thus both collect food for the community. In England the masters alone usually leave the nest to collect building materials and food for themselves, their slaves and larvæ."

"The Formica rufescens," says Darwin, "is absolutely dependent upon its slaves. Without their aid the species would certainly become extinct in a single year. The males and fertile females do no work of any kind; and the workers, or sterile females, though most energetic and courageous in capturing slaves, do no other work. They are incapable of making their own nests or of feeding their own larvæ. So utterly helpless are the masters of these animals that, when Huber shut up thirty of them without a slave, but with plenty of the food which they like best, and with their own larvæ and pupæ to stimulate them to work, they did nothing. They could not even feed themselves, and many perished of hunger. Huber then introduced a single slave and she instantly went to work and saved the survivors." These remarkable phenomena the great Darwin seemed content to class as instinctive. But, whether due to instinct or not, it is mental and, therefore, psychical.

Next in the order of unconscious intelligence stand the mental phenomena of the hive bee. They are closely allied to those of the ant, and are too well known to be more than referred to here. Without a cerebrum, possessing nothing comparable to one but sensory ganglia, the bee has never ceased to astonish the physiologist by the number and variety of its "purposive actions, without consciousness of its purpose." The bee, however, does not confine its actions to the sphere of instinct as recognized by the typical physiologist, for it does not conform itself to fixed rules, or a regular uniform method. For example, Huber, by special contrivances, prevented bees from carrying on their instinctive mode of building from above downward, whereupon they built from below upward, and even horizontally—conduct more complicated than that typical of instinct. The sense of instinct is better illustrated by the actions of a caterpillar observed by the same author, which, having completed its hammock to its third stage, was put into one already completed. It seemed at first much embarrassed by the new situation and finally was forced to go back to the point of its own hammock, at which it had itself left off, executing anew the fourth, fifth and sixth stages, which had already been wrought out.

The bee, moreover, performs other acts which are above instinct, in the usual conception of that term; for it carries on operations which require the co-operation of other bees and a guiding, directing mind, very much like similar operations among men, even to the division of labor. For instance, in constructing its hives, the bee works in gangs, in a manner altogether similar to works requiring joint combinations of men, under a single head or leader, one bee confining itself to a particular kind of work, as excavation, another to wall building, another to the ceiling, and so on to the number of a score or more workers, in the completion of their marvelous work, which is all the more marvelous of them by reason of absence of language or other visible means of communication among the workers. Surely, no operation of conscious intelligence is more extraordinary than this, which is carried on, not by the bees really, but through the bees, by the laws of the unconscious.

A higher and equally interesting order of instinctive phenomena, due, as the physiologists would say, to the presence of sensory ganglia, is observable among the higher vertebrates—the domestic fowls, for example. The chick breaks its own shell, in which it is hatched, with the tip of its bill, and helps itself into the external world, gets on to its legs, and forthwith begins to peck at insects, seeds, etc., with unerring aim. In this connection the experiments of Mr. Spalding, of England, are apropos. This gentleman contrived to have chickens hatched and kept secluded in a bag for a day or two, when, on being taken out, they would almost immediately "set off straight for the box in answer to the call of the hen, though they had never seen her and had never before heard her voice." "This they did," he observed, "struggling through the grass and over rough ground, and when not yet able to stand steadily on their legs." The same writer remarks that a turkey but ten days old, which had never seen a hawk, was so alarmed by the note of one secreted in a cupboard that "it fled in a direction opposite to the cupboard with every sign of terror."

Of the habits of most animals which are supposed to be guided by instinct, unconscious intelligence would afford a better explanation, since such animals adopt unconsciously the proper means to a desired end, these means constantly varying according to varying circumstances. For example, in cold climates, birds sit on their eggs in order to hatch them. In warm climates they leave them to be hatched by the sun, because, as Von Hartmann says, the bird "sees the goal of its instinct attained without its assistance." When circumstances are such as to place its eggs or its little ones in jeopardy, the birds hide their nests, some in the sand, others in caves, holes, thick foliage, shrubs, grass, etc. "In South Africa the sparrow begirds its nest with thorns as a protection against snakes and apes." How different, too, are the styles of nest building among birds of the same species, in the mode of building materials used, place of building, etc., the best means to the desired end being usually kept in view! Some birds, moreover, build no nests at all, resorting to other and less troublesome but equally effective means of caring for their brood. The cuckoo, for example, deposits its eggs in the nests of other birds, to be hatched and tended by them. They hide their eggs, so to speak, among the eggs of other birds; and what is most remarkable, although its eggs are of different colors and sizes, among the various species of cuckoo, each cuckoo lays its eggs in nests of birds whose eggs are as nearly as may be of the color and size of its own. Otherwise, the device would fail, and the end be defeated.

"Instinct is the voice of God," said Kant, to which Von Hartmann responds, "Yes—the God in one's own breast, the Immanent God." No one with an adequate conception of the marvels displayed by these low species of being, in adapting means to ends, can fail to be impressed by them as was the illustrious Kant. If it be not God, it is a psychic power possessing the attributes which one ascribes to God. One cannot escape from the conclusion to which these phenomena lead.

LÆLIO-CATTLEYA × ROSALIND.

Segments silvery-white; lip yellow at the base, purple in front.

LÆLIO-CATTLEYA × ROSALIND (C. TRIANIÆ ♀, L.-C. × DOMINIANA ♂).

OUR illustration represents the above-named beautiful hybrid, for which Messrs. James Veitch & Sons, Royal Exotic Nursery, King's Road, Chelsea, received a first-class certificate when they exhibited it before the orchid committee of the Royal Horticultural Society on December 15 last. The general opinion of judges who saw it was that it is one of the very best hybrid orchids of the year. There were only two plants raised, each differing from the other. They both passed into Baron Schroder's collection. About the parentage of L.-C. Dominiana there always existed doubts, but it is generally supposed to have been between Lælia purpurata and Cattleya Dowiana.

L.-C. × Rosalind has French-white sepals and broad,

silvery-white petals, over which, except on the margin, there is a delicate tinge of pale rose-pink. The lip is rich yellow at the base, with clear white veining, the side lobes being rosy-purple, with blush-white veins, and the front bearing a rich dark purple blotch.

THE PROGRESS OF ASTRONOMY IN 1896.

UNQUESTIONABLY the astronomical event of the year that has just passed which attracted the greatest amount of popular interest and attention was the total eclipse of the sun, which occurred on August 9, for the observation of which expeditions were equipped and elaborate preparations made by nearly every civilized nation on the globe. It is a thrice told tale by this time how all the heavy cost and trouble involved would have been thrown away, but for the good fortune of a handful of observers, who, separating themselves from the crowd, repaired to stations which were not in the official programmes at all. Among the expeditions which failed utterly were the English and American ones to Japan, a large and important one organized by the British Astronomical Association to Vadsö, and a second one dispatched, at the public expense, to a point also close to the Varanger Fjord. On the other hand, the passengers on board of the Ohio, an American steamer (among whom was Miss Mary Proctor, the daughter of the eminent deceased astronomer), who were stationed near Bodo, M. Lous, in the same neighborhood, and Baron Kaulbars, of the Russian expedition, who observed in Russian Finland, obtained splendid views of the phenomenon, and of the curious extensions of the corona. It is, however, to the munificence and public spirit of Sir George S. Baden-Powell, M.P., that the scientific world is indebted for by far the most valuable observations of the eclipse that were made at all for he conveyed a party, including Mr. E. J. Stone, the Radcliffe observer, and Mr. Shackleton, an assistant at South Kensington, to Novaia Zemlia in his yacht, the Otaria, whose results equal or surpass in interest those of all the other expeditions which have so far come to hand. By the aid of a simple but efficient diagram, the members of the party and crew were enabled to draw separately what they could see of various extensions of the corona, with the result that a very satisfactorily coincident series of sketches was obtained, and the corona, as a whole, was found to conform to the shape supposed to be typical of a period of intermediate solar activity. Mr. Stone, moreover, succeeded in photographing a great deal of solar detail, while to Mr. Shackleton belongs the honor and credit of having been the first man to photograph the so-called "reversing layer" of bright lines in contact with the sun's limb, which was originally seen by Young during the eclipse of December, 1870. The importance of this achievement will be more evident when a direct comparison of the lines impressed upon the plate with the Fraunhofer ones shall have been completed.

In connection with solar observation, we may further mention that M. Sykora, of the Charkoff Observatory, has been making an elaborate series of measures of the sun's diameter, and finds that such diameter is increased when measured at points of his limb where spots are just appearing or disappearing. Should this be established, it points unmistakably to the spots being elevations above the surface of the sun, and not (as the Wilsonian hypothesis requires) depressions below it. Independent research, on totally different lines, has led Prof. E. B. Frost, of the Dartmouth Observatory, to a similar conclusion.

About the end of May or the beginning of June sunspot activity very notably diminished, and the exponents of "solar physics" predicted that the time of minimum had either arrived or was imminent; but during the second week in September a large and magnificent stream of spots extending over some 24° of solar longitude became visible, and since then there has rarely been a day on which the sun has been quite free from spots.

A fresh determination of the solar constant, or the number of "calories" received normally in one minute on a surface one centimeter square at the upper limit of the atmosphere, has been made by M. Vallot. As the result of a number of observations, he arrives at the conclusion that this solar constant can scarcely amount to two calories, finding 1·75 calories to be its mean value. It may not be wholly useless to put the quantities given above into plain English, and to say that a calorie is the quantity of heat required to raise 15·433 gr. of water from 32° F. to 33·8°, and that one centimeter^2 = 0·155 sq. in.

Yet another value of the solar parallax has been deduced by Prof. Newcomb from the amount of the parallactic inequality of Delaunay's lunar theory. It comes out 8·775", and corresponds to a mean distance of 93,182,320 miles between the centers of the earth and sun. It has met with no acceptance and is merely of theoretical interest.

The question of the period of the earth's rotation is still sub judice. It is a familiar fact that inequalities of long period exist in the moon's orbit, which are unaccounted for by the present theory. Among other attempted explanations of this may be mentioned one that the adopted length of the mean solar day is incorrect, involving the supposition that the time of the earth's rotation is not uniform. To test this, Prof. Newcomb has been employing the transits of Mercury up to that of 1894 as a standard of comparison, with new tables of Mercury of his own construction. The result of this comparison seems to favor the hypothesis that the earth's time of rotation slackened between 1796 and 1789, as it did again between 1840 and 1861; but that between 1862 and 1870 a strongly marked acceleration occurred. At present, however, nothing approaching to proof exists that any change whatever has taken place in the period in which the earth turns on her own axis, and all such results must be regarded as mere mathematical tours de force. As we write, news comes from Berlin that, as the result of twelve years' consecutive investigations, Prof. Richarz and Dr. Menzel have found the density of the earth to be such that she must weigh 54,681,000,000,000,000,000,000 tons.

Herren Brenner and Weinek have continued to add to our selenographical knowledge; the former by the aid of the excellent Manora telescope and his own exceedingly acute vision for faint markings and minute detail, and the latter by his very beautiful enlargements from the Lick lunar photographs. The fame of the photographs which MM. Loewy and Puiseux continue to produce is, of course, world wide.

If we open any work on descriptive astronomy published more than six or seven years ago, we shall find the rotation period of Venus stated to be 23 hours, 21 minutes, 22 seconds, or thereabout. But some time in 1890 the famous Italian observer Schiaparelli astonished the astronomical world by proclaiming, as the result of certain observations made in 1877–78, that so far from the planet rotating in a slightly shorter time than the earth, her periods of rotation and revolution were coincident, and that she really took some 225 days to turn on her axis. M. Perrotin, of the Nice Observatory, set himself specifically to corroborate this remarkable period; and, like a good many other people who start with strongly preconceived ideas, succeeded in finding what he set out to establish. But M. Niesten, of the Royal Observatory at Brussels, in conjunction with M. Stuyvaert, carried out an elaborate series of observations of Venus between the years 1881 and 1890, and was enabled to detect spots on her surface of sufficiently definite a character to permit of a fair map of her surface being made; showing, as the result, that Schiaparelli had fallen into the mistake of considering that the slight displacement of a given marking on successive evenings had its origin in the exceedingly slow rotation of Venus, and quite ignoring the fact that the planet had during the interval made one whole rotation and a very little more. The Belgian results, we need hardly add, were subsequently in every way corroborated by that splendid astronomical draughtsman, the late lamented M. Trouvelot, at Meudon; and again quite recently by the elaborate and extensive observations of our own esteemed correspondent, Herr Leo Brenner. With the researches of the last-named astronomer the question may well be held to have been set at rest; but, quite recently, Mr. Percival Lowell, observing in Arizona, claims to have established that Schiaparelli was right, after all. At present there is a consensus of opinion that Mr. Lowell has simply fallen into Schiaparelli's mistake over again —that is all.

Wonders have continued to accumulate on the face of Mars during the year which has just passed, and here again Mr. Lowell is well to the front. "Canals" increase and multiply to an alarming extent on our neighbor in space, and the duplicity of these "canals" is now supposed to have its origin, not in the waterways themselves, but in the belts of vegetation which, like the poplars on a French highroad, fringe their margins. Meanwhile, we believe that the Lick observers—or one of them—hold that the lighter parts of the planet's disk are water and the dark ones land, which rather puts this agricultural, or horticultural, theory out of court. At any rate, with what has been actually seen or glimpsed, and what has been imagined, the disk of Mars appears to be now covered with a network of such intricacy that no two observers can map it alike. A ridiculous paper on the possibility of communication with Mars appeared in the Fortnightly Review for November. Happily, it was not written by an astronomer.

Since the application of photography to stellar charting, the discovery of planetoids between Mars and Jupiter has gone on apace, 440 (more or less) of these bodies having been recognized as such up to the date at which we write. Of these, M. Charlois is to be credited with the discovery of no less than eighty-eight, five of them during the year 1896, during which nineteen additions altogether have been made to the already overgrown list. With telescopes of the enormous aperture now constructed, and with sufficiently prolonged exposure, there seems no particular reason why this number should not ultimately swell to four thousand four hundred; for on the night of September 7 Wolf photographed five of these bodies, previously undetected, all on one plate!

Prof. Schur, from a series of measurements of Jupiter's diameter made during the years 1891-96 with the Göttingen heliometer, deduces the value of the equatorial diameter as 37·42", and 35·13" as that of the polar diameter. This is, in each case, about 1" less than the corresponding results obtained by means of the filar micrometer.

If published observations are to be depended upon, M. Antoniadi at Juvisy has made a curious discovery in connection with the physical structure of the Saturnian system, which would seem to indicate that changes go on in the visible appearance of the rings almost as striking as those exhibited by Jupiter's belts; for he believes that he detected three separate divisions in the inner bright ring (thus dividing it into four). It may be remembered that subdivisions of ring B had previously been suspected by Sir William Herschel, De Vico, Bond, Coolidge, and Asaph Hall. Prof. Keeler's spectrographic determination of the rotation of Saturn's rings as an aggregation of small particles or satellites (of which we spoke last year, on p. 435 of vol. lxii) has been corroborated during the past twelvemonth by Prof. Belspolsky, with the 30 in. achromatic of the Pulkova Observatory.

During the year just gone by, Prof. E. E. Barnard has published the results of his micrometrical measurements of Uranus and its satellites in 1894-95. Struck during these observations with the ellipticity of the planet, he carefully determined the position of the major axis of the ellipse, and—assuming this to lie in the plane of the equator of Uranus—finds that such plane is inclined some 20° or 30° to that of the orbits of the satellites. Some photometric determinations showed that Ariel was the brightest of them, Umbriel being half a magnitude less; Titania and Oberon coinciding in brightness. This last result, however, is subject to the qualification that where two satellites of equal brightness are situated one vertically over the other, Prof. Barnard always sees the top one the fainter of the two.

September 23, 1896, was the jubilee of the actual discovery of Neptune by Dr. Galle in Berlin. Mirabile dictu, no fussy idiot even suggested the celebration of this marvelous triumph of pure science by a dinner, monument, or public subscription.

No very notable advance has taken place in our knowledge of meteoric astronomy during the past twelve months, though the chronic discussion on the meaning of stationary radiants, etc., continues. A huge meteorite exploded over Madrid at 9 h. 29 m. A. M. on February 10, emitting a blinding light (although the sun was shining brilliantly), breaking windows, and even shattering partitions by the concussion, coincident with a loud report. Two brilliant meteors were seen in England on the night of September 10. The first appeared at 9 h. 3 m. P. M. It was seen by several observers at Bristol, Exmouth, Yeovil, etc. It apparently traveled from a radiant near Capella. The second was seen right across England from London to Bristol. It is supposed really to have traveled over Herefordshire. Its seeming radiant was close to β Cephei. We hear, too, of the fall of an enormous meteor on November 17, in lat. 48° 10′ N. and long. 2 h. 56 m. W., some two miles in front of the steamer Wilkommen. The trail of light it left, after plunging into the Atlantic, lasted several minutes. Great popular disappointment was felt in November by the numerous band who were prevented from observing the familiar shower of Leonids on the night of the 13–14th, as an exceptionally fine shower had been predicted. Nothing abnormal, however, appears to have been observed, even where the sky was clear.

Six comets have appeared in 1896. The first was found by Perrine at Mount Hamilton, on February 15. Its discovery was verified by Dr. Lamp at Kiel, on receipt of a telegram from Mr. Perrine, and the comet has since been known (for no very obvious reason) as the "Perrine-Lamp" one. The most conspicuous comet of the year was that detected by Dr. Lewis Swift on April 15—this had a short tail. Its orbit was undoubtedly parabolic. On September 4 two comets were discovered: one by Giacobini at Nice and the other by Brooks at Geneva, in the United States. It was subsequently found that this latter object had been found by Mr. E. W. Sperra, of Randolph, Ohio, four days previously. A strange story from Dr. Lewis Swift reached this country a short time afterward. It was to the effect that he had, on September 20, seen a bright comet only about 1° from the setting sun, with a fainter companion some 30° north. These objects set four minutes after their detection, but not until fifteen people had verified their existence. One of them was picked up in a comet seeker for a few seconds on the succeeding evening, after which they were no more seen. Perrine, at the Lick Observatory, found another small comet on November 2, and yet a third on December 8; this last one being sufficiently bright to exhibit a nucleus like an 8th magnitude star, and a tail nearly 30′ long.

The astrographic chart proceeds apace, and the majority of the observatories have practically now completed their respective series of catalogue plates, the operations only of three South American ones having been impeded by chronic revolutions, and those of a Sicilian one by impecuniosity. In connection with celestial photography, we may mention that Dr. Isaac Roberts continues to pursue his plan of photographing nebulæ and cognate remarkable objects in the stellar vault, and that the first part of an atlas of the moon from the unsurpassed negatives of MM. Loewy and Puiseux has been published. This, when completed, will unquestionably surpass every previously attempted delineation of the lunar surface in accuracy and beauty.

No apparition of a new star (save a minute one in Centaurus on a photographic plate), nor any allied sensational phenomenon, has occurred in the stellar vault during the year which has just ended; but the usual attention has been paid to all the well-known variables by those of the observers of these anomalous bodies whose names are familiar to the public. The greatest of all living double star observers, Mr. S. W. Burnham, has published a sorely needed caution against the computation of the orbits of real or supposed binary stars, showing that even motion in a straight line (!) will, in a large number of cases, perfectly satisfy observed position angles and distances.

Among miscellaneous occurrences connected with astronomy may be mentioned the opening of the new Scottish Royal Observatory on April 7; the founding by the government of West Australia of a new one at Perth, W. A.; and the establishment of four more in the United States by the Illinois legislature, and by the Universities of Ohio, Minnesota and Pennsylvania respectively. The Yerkes Observatory is slowly approaching completion. A new time system, based on the Greenwich meridian, has been adopted throughout South Africa. The time employed in Cape Colony is now 1 hour 30 minutes fast of Greenwich, and that at Natal two hours fast. The splendid work at Harvard Observatory continues without cessation or intermission, and the magnitude of every star of the sixth magnitude or brighter in the entire celestial vault has now been rigidly determined there. Pari passu, stellar spectroscopy has been pursued with the most valuable results. During 1896 that princely donor to astronomical research, Miss Catherine W. Bruce, has continued her invaluable aid to science by gifts to the University of Chicago and both to the Lick and Manora Observatories as well. By a unanimous resolution of convocation of the University of London, its senate was appealed to in November last to take steps for the establishment of a students' observatory in the neighborhood of London. The result of this appeal has not yet been made public, but its object is obviously a most desirable one. Owing, unfortunately, to ill health, M. Folie has perforce resigned the directorship of the Brussels Observatory, after holding it for eleven years.

The British Astronomical Association continues its really marvelous progress seemingly without cessation or intermission. At its meeting in November no less than sixty-seven new candidates were elected to the membership, and the total number of its members can, by this time, be very little, if at all, short of 1,150. Nor is its younger sister, the Astronomical Society of Wales, behindhand in the race; for, although it may fairly be regarded as a local association, its numbers now amount to something like 200, so mightily has popular interest in astronomy grown and prevailed.

Among the novel forms of instruments that have appeared in the past year, the first place must be given to the one devised by M. Zenger, of Prague, which he calls the eclipsoscope. In effect it consists of a crown glass, or quartz, cone inclosed in a zinc cylinder, whose ends are closed by plane glass plates, the empty part of the cylinder being filled with a mixture of anethol and terebenthine. Over the window at the apex of the cone is placed a tin disk in which a circular annulus 0·1 in., or less, wide, is cut. This is arranged so that the center of the disk lies in the optical axis of the cone. Optically, this constitutes an infinite number of direct vision spectroscopes, and is used with a telescope furnished with a Barlow lens. The image of the sun is

thrown on to the tin window so that its diameter just overlaps the inner diameter of the annulus, and then by the interposition of a mixture of aniline violet with a little aniline green all the rays, except the red hydrogen ray, are absorbed, and the prominences are seen in red light with the chromosphere, and the whole of them round the sun at any given time are thus seen at once. Dr. Russell, of the Sydney Observatory, has devised a new form of photographic transit circle, differing entirely from the star trail one. It is equatorially mounted and driven by electrically controlled clockwork. No description of it would be very intelligible without a diagram. What is really observed is the passage of divisions of an hour circle 3 ft. in diameter.

The noteworthy additions to astronomical literature in 1896 have been but few. Among them we may mention Mr. Percival Lowell's work on Mars, suggestive as it is in parts of one of Jules Verne's stories. Dr. Orchard has brought out a large and handsome book on "The Astronomy of Milton's 'Paradise Lost,'" from which really a good deal of astronomical information may be gleaned. Probably the most important work that has appeared is that on "The Indian Calendar," by Mr. Robert Sewell and Pandit Sankara Balkrishna Dikshit, with tables of eclipses visible in India by Dr. R. Schram. This contains tables for converting any Indian date between A. D. 300 and 1900 into its equivalent one A. D. and vice versa, while the eclipse tables will prove invaluable to all wishing to compute the details of Indian eclipses and the localities whence they may be, or have been, observable. We may mention that a new and revised edition of Ball's excellent "Elements of Astronomy" has been published during the year. Several smaller works of utility to the astronomical amateur have appeared, such as the fifth edition of Calver's "Hints on Silvered Glass Reflecting Telescopes;" Lynn's two handy brochures on "Remarkable Comets" and "Remarkable Eclipses;" and Chambers' "Story of the Stars" and "Story of the Solar System." The Nautical Almanac for 1899 is worthy of its superintendent, Dr. Downing. We know of no higher praise that we could bestow upon it. Mr. Whitmell has quite recently reprinted an excellent essay on "The Moon as a View-Point" from the Transactions of the Cardiff Naturalists' Society.

Death has been terribly busy in the ranks of astronomers during the year which has just come to a close. The first to be taken was Mr. G. P. Bidder, Q.C., who died on February 1, from the effect of an accident. He inherited a remarkable power of mental calculation and was, at one time, a constant attendant at the meetings of the Royal Astronomical Society. He was followed, on February 16, by General Walker, who will be remembered as the successor of Sir Andrew Waugh as director of the great Indian trigonometrical survey. On April 21 there passed away a man to whom astronomical science was largely indebted in the person of Dr. N. A. Krueger, director of the Kiel Observatory, as he had previously been of those at Helsingfors and Gotha. He was one of the original workers with Argelander at the well known "Durchmusterung," and was the author of numerous papers on gravitational astronomy. Probably, however, he is best known to the general scientific world as editor of the Astronomische Nachrichten, and as the originator of the system of telegraphic exchanges between the various observatories in the world. By the death of Mr. George Hunt on July 9, a familiar face disappeared from the R.A.S. and R.M.S. meetings. Mr. Hunt was the possessor of the famous equatorial belonging to the late Rev. W. R. Dawes, which is now the property of Mr. W. H. Maw. Not long afterward the news of the death of Prof. H. A. Newton, of Yale University, reached this country. He will be remembered as the author of many elaborate papers on the orbits of meteors and cognate subjects. In September, too, died Hippolyte Fizeau, the famous French physicist, whose name will always be associated with the measurement of the velocity of light. And on September 21, after a short illness, Prof. Winlock, assistant at the Smithsonian Institution, passed away. He was, so to speak, an hereditary astronomer, and quitted the United States Naval Observatory to take the office which he held at the time of his premature and lamented death. By the untimely death of M. Tisserand, the director of the Paris Observatory, on October 20, the world lost a brilliant mathematician and able gravitational astronomer, and one, moreover, intimately acquainted with the science in its practical aspect. His "Traité de la Mecanique Celeste" must always remain a classic. The Paris Observatory sustained all its ancient renown during the four short years of his administration. Prof. J. A. H. Gylden, the eminent director of the Stockholm Observatory, died suddenly of paralysis of the heart at the Observatory on November 9. He was renowned for his lectures, which were attended by students from all parts of Europe. His researches in the subjects of stellar parallax and the proper motion of stars are familiar to all astronomers, and his essays on gravitational astronomy both original and valuable. We have next to chronicle the death, on November 27, from an accident, of Dr. B. A. Gould, known far and wide as the editor of the Astronomical Journal, and as the author of that splendid work the "Uranometria Argentina," for which the gold medal of the Royal Astronomical Society was awarded to him in 1883. He is a great and irreparable loss to the science, and will with difficulty be replaced. Lastly, we learn of the death of another medalist of the Royal Astronomical Society, Prof. Axel Moller, of Lund, to whom that medal was awarded in 1881, for his investigations on the motion of Faye's comet. His chief distinction was won in the field of gravitational astronomy.—English Mechanic and World of Science.

CHEAP ASTRONOMICAL SLIDES.

PROCURE some sheets of thin black cardboard, the size of a lantern slide (3¼ inches by 3¼ inches), place one of them beneath a diagram, of which many will be found in such works as "Popular Astronomy," and mark the positions of the various stars and planets with a needle point. Then remove the card and pierce the holes with various sized needles or punches, and mount it in contact with a glass plate to give it the necessary rigidity. Different planets can be distinguished by different colors by the simple expedient of covering the apertures with different colored gelatine, such as is used to cover Christmas crackers. Such slides are very effective, and are far more brilliant than any that can be made on glass. The orbits of the planets can be marked by fine needle holes placed close together.—Amateur Photographer.

ALLOYS OF IRON AND NICKEL.*

By Prof. M. RUDELOFF.

A SPECIAL committee having been appointed to study the properties of iron alloys, Prof. M. Rudeloff, Assistant Director of the Royal Prussian Testing Department, reported recently to the Verein zur Befoerderung des Gewerbfleisses on alloys of iron and nickel. Thirteen different mixtures were produced, three ingots from each mixture. The ingots weighed 20 kg. each and measured 15 inches in length, 2¼ inches thick and 4 inches wide. Their chemical composition is given in Table I.

Chemical Composition of the Iron Used.

	Iron.	Carbon.	Mang.	Silicon.	Phos.	Sul.	Copper.	Nickel and Cobalt.
Per cent	99·710	0·070	0·079	0·013	0·007	0·013	0·068	0·039

Chemical Composition of the Nickel Used.

	Nickel.	Iron.	Cobalt.	Copper.	Silicic Acid.	Carbon.	Sulphur.	Alkalies, Lime and Alumina.
Per cent.	98·21	0·25	1·19	0·07	0·24	Trace.	Trace.	Trace.

Percentage of Nickel Aimed at in Each Group of Three Ingots—Ingots No. 1-3 were Pure Iron; No. 37-39 Pure Nickel.

Ingot No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21
Per cent. of nickel..	0·00	0·50	1	2	3	4	5
Ingot No.	22-24	25-29	28-30	31-33	34-36	37-39	
Per cent. of nickel..	8	15	30	60	95	100	

The method of melting the material was uniform in all cases. The fuel used was coke and the melting was done in graphite crucibles. Before pouring a small amount of aluminum, or magnesium, or ferromanganese was added to make the metal more fluid. At first the inside of the mould was washed with chalk. This proving objectionable, causing cheeks and rough surface of the ingots, a clay wash was substituted with better results.

The pure iron, and mixtures rich in iron, required the addition of 20 grammes of aluminum to 20 kilogrammes of metal to produce the required fluidity for casting. On the other hand, 10 grammes of magnesium prevented spongy ingots with the nickel, or mixtures rich in nickel. For the purpose of chemical analysis the ingots were sawed in two and the surface planed. The chips thus obtained were then used for chemical analyses. The strength of the alloys produced was ascertained by tensile and shearing tests, by slow compression and crushing under the drop. Three test pieces from each ingot for each kind of test were prepared. The degree of expansion by heat was determined on four ingots, one of pure iron and pure nickel each, and one with 4 and 16 per cent. nickel respectively. By the tensile test the elastic limit, yield point, breaking strength and elongation were determined. Average results of tests are given in Table II. In Table III the proportional strength of alloy to pure iron is given, the iron being taken as 100. In the compression tests the yield point was determined and the percentage of reduction from the original height, under a load of 160,000 pounds per square inch. Results are found in Table IV.

In the drop tests, 20 blows were given with a drop weighing 125 pounds, falling 9¼, 18½, 37 inches respectively. Results are given in Table V. Shearing tests were made by inserting the test pieces in suitable holes of hardened steel washers, two of which were recessed in suitable blocks, one in each block, while a third washer sliding between the other two served as a shear by being forced down by means of a shear plate encircling the washer partly, and upon which pressure was exerted. Results are given in Table VI.

SUMMARY OF RESULTS OF TESTS.

Expansion by Heat.—The coefficient of expansion by heat was found to decrease with the increase of percentage of nickel, but was greater with the 98 per cent. nickel than with the pure iron. Taking the value of pure iron as 100, the difference in expansion was:

	Per cent.
Iron and 4 per cent. nickel—.....	5·7
Iron and 16 per cent. nickel—....	10·9
Iron and 98 per cent. nickel +.....	9·1

Or 94·3, 89·1 and 109·1 respectively.

Chemical Analyses.—A detailed examination of the analyses warrants the conclusion that the addition of nickel to iron does not appreciably influence the chemical contents of the iron in foreign elements. On the other hand, all foreign elements in the nickel are also found in the iron nickel alloy.

Table I.—Results of Chemical Analyses of Ingots. Average of Three Ingots.

Percentage of Nickel Aimed at.	Per cent. of Iron.	Per cent. of Nickel.
0·00	99·59	0·05
0·50	98·99	0·76
1·00	98·75	1·01
2·00	97·72	2·05
3·00	96·63	3·00
4·00	95·81	3·98
5·00	94·81	4·92
8·00	91·89	7·84
16·00	84·12	15·59
30·00	69·74	29·77
60·00	39·69	59·60
95·00	5·15	93·68
100·00	0·33	98·89

Tensile Tests.—The elastic limit, yield point and breaking load rise until the percentage of nickel reaches about 10 per cent. Thence a decrease takes place of these values until the nickel reaches 30 per cent. With a further increase of nickel, the elastic limit and yield point decrease still more, while the breaking load is higher with 60 per cent. nickel than with 30 per cent., whence it decreases again.

The elongation decreases as the percentage of nickel increases and is almost zero at 16 per cent. nickel. From thereon elongation increases until with 60 per cent. nickel its maximum is reached, declining then with increase of nickel.

It will be seen that the elastic limit and yield point of pure nickel is only about 60 per cent. of the pure iron, the breaking load of the two metals are nearly the same, while the elongation of pure nickel is about 60 per cent. of that of the pure iron.

The elastic limit is raised highest by the addition of nickel, next the yield point, and then the breaking strength. The structure of the metal is likewise changed with changes in the percentage of nickel. In the pure iron the structure is amorphous. With 0·5 per cent. nickel the tensile fracture begins to get granular. With 5 and 8 per cent. nickel the structure is pronounced crystalline, the crystals assuming the shape of needles with 16 and 30 per cent. nickel, this structure continuing to the end of the series. With 0·5 per cent. nickel the ingots have a tendency to be honeycombed. They become sound with 1 per cent. nickel, continuing to be so up to 30 per cent. nickel, when the ingots exhibit oxidation in their interior.

Table II.—Average Results of Tensile Tests.

Per cent. of Nickel.	Elastic Limit, lb. per sq. in.	Yield Point, lb. per sq. in.	Breaking Strength, lb. per sq. in.	Elongation, Per cent. in 2 Inches.
0·05	8,535	20,768	46,100	29·7
0·76	8,819	22,617	45,652	20·6
1·00	10,242	23,613	47,938	26·4
2·05	14,500	28,734	52,632	22·7
3·00	22,900	34,144	57,753	20·1
3·64	23,630	28,265	57,750	17·6
4·93	27,881	46,230	63,443	10·8
7·84	32,433	62,874	79,944	9·6
15·60	22,760	.....	58,322	0·6
29·78	8,962	17,781	14,225	2·2
59·66	8,535	17,780	53,770	36 1
93·55	5,832	15,363	47,221	19·0
98·56	5,121	12,944	43,386	17·1

Table III.—Proportional Strength of Alloy to Pure Iron, Taking Iron as 100.

Per cent. of Nickel.	Elastic Limit.	Yield Point.	Breaking Load.	Elongation in 1 Inch.
0·0	100	100	100	100
8	380	303	173	30
16	267	280	126	2
30	105	86	31	8
60	100	86	117	103
98	60	62	94	50

Compression Tests.—The resistance of the alloys to compression does not seem to differ in different parts of the ingot. The resistance increases steadily until 16 per cent. nickel is reached, whence it begins to decrease until at 94 per cent. nickel the resistance is only 50 per cent. of the pure iron. There is a small increase again with 98 per cent. nickel. Thus, generally speaking, the behavior of the alloys under compression is similar to their behavior under tension.

Table IV.—Average Results of Compression Tests.

Per cent. of Nickel.	Yield Point, lb. per sq. in.	Per cent. of Reduction of Test Piece Under a Head of 160,000 lb. per sq. in.
0·05	25,900	47·8
0·56	22,500	47·4
1·01	28,300	45·5
2·06	37,200	42·1
3·01	40,700	38·8
3·98	40,100	37·5
4·92	54,900	34·1
7 84	72,500	29 2
15·60	163,000	0·7
29·78	30,300	37·5
59·60	22,900	33·1
93·52	13,900	34·6
98·89	18,000	36·9

Drop Tests.—The results of drop tests are more or less a repetition of the metal as exhibited in the compression tests. The strength increases up to 16 per cent. nickel, reaches the value of pure iron with 30 per cent. nickel, remaining in that condition to the highest percentage of nickel in the alloy.

Table V.—Average Results of Drop Tests.

Per cent. of Nickel.	Per cent. Reduction of Test Piece.		
	Distance of Weight Falling, 9¼ Inches.	Distance of Weight Falling, 18½ Inches.	Distance of Weight Falling, 37 Inches.
0·15	64·7	76·0	84·4
0·56	(63·3)	(76·7)	....
1·01	63·6	76·2	83·3
2·05	60·7	75 8	81·7
3·00	57·6	73·5	82·0
3·98	58·0	72·9	80·4
4·92	54·9	71·8	81·1
7·84	51·6	68·7	78·7
15·59	(25·3)	(46·7)	70·0
29 77	60·0	72·7	80·4
59·60	56·2	71·1	78·7
93·68	(58·0)	(71·9)	78·7
98·39	60 0	72·7	80·4

Figures in parentheses represent averages of less than three tests.

Shearing Tests.—The phenomena exhibited by the metal under shearing tests are very much like those ob-

* From the Verhandlungen des Vereins zur Befoerderung des Gewerbfleisses.—The Iron Age.

served at the yield point when the metal is under compression.

Table VI.—Average Results of Shearing Tests.

Diameter of Test Pieces.		Diameter of Test Pieces.	
Per cent. of Nickel.	Load Applied to Shear in lb. per sq. in.	Per cent. of Nickel.	Load Applied to Shear in lb. per sq. in.
0·05	37,800	7·84	61,870
0·56	36,800	15·60	96,300
1·01	40,400	29·78	50,200
2·06	43,400	59·60	53,900
3·01	47,400	93·52	50,800
3·98	49,100	98 39	49,400
4 92	52,000	. . . .	....

A RARE METAL.*

By T. L. PHIPSON, Ph.D.

AT the beginning of this century the great Swedish chemist Berzelius discovered a new metal in some Norwegian rocks, and dedicated it to the mythological deity of the ancient Scandinavians, the god Thor, by calling it thorium; the mineral in which it was found was also called thorite.

It was at a period at which great activity was manifested in the search after new substances contained in rocks, minerals and rare or precious stones. Chemists had not yet made much way into the mysteries of the organic world. They were not acquainted with the marvelous products which have since been derived from plants; animal chemistry was very little known; but a great insight was being obtained into the nature of the constituents of minerals, and ever since the middle of the eighteenth century discoveries of new metals were being made with astonishing rapidity.

During this extremely interesting period of scientific research, when men like Humphry Davy, Lavoisier, Klaproth and Berzelius vied with each other as discoverers of the secrets of nature, considerable numbers of most curious substances were brought to light—metals which, to this day, are scarcely known, even by name, to the general public, and are still little enough known, indeed, to the most eminent of our modern chemists. Cerium, for instance, was found in a kind of granite rock in Sweden, glucinium in the emerald and beryl, zirconium in a precious stone from the East called jargon, and titanium in the black sand of some Cornish streams.

When a new substance is thus discovered, the thought that it may some day be applied to a useful purpose is generally quite absent from the mind of the discoverer. He is perfectly satisfied with the novelty of the discovery. Only those who pass their existence in a laboratory devoted to research can realize the intense interest with which every new property of these rare curiosities is studied. The book of nature is really more attractive than the finest pages of the greatest writers, and as its secrets are gradually revealed they rivet the attention more and more, quite independently of the possible application of these revelations to any particular art or industry. Nevertheless, it must be confessed that in these practical days such considerations are not always so entirely absent from the mind as they used to be.

It is needless, perhaps, to say that, of all the new metals which have come to light since the middle of the last century, very few have come to any extent into daily use. Hitherto, by far the most unpromising, perhaps, in this respect, has been the metal thorium, and its oxide thoria. It was found in a black, shiny mineral, resembling black glass, sticking in the Norwegian granite rocks, and afterward in a few other stones of various colors, where its presence was thought to be accidental. It possessed no very striking properties. The oxide (thoria) is white, and forms white salts with acids; no colors are obtained with it. In fact, it was no more interesting in its chemical behavior with other substances than common lime, to which it bears a good deal of resemblance. But it was very heavy, very infusible, and very rare; and it was certainly quite distinct from any substance which the crust of the earth had, as yet, yielded to the inquisitive searcher after new metals.

Thoria was first found combined with silica upon the little island of Loeven, not far from the small town of Brevig in Norway. It was discovered by a Swedish diplomatist named Esmarck, and handed to his friend the chemist Berzelius, that he might analyze it and so find out what it was. In making this analysis Berzelius soon discovered that he was dealing with an entirely new substance. Some time afterward the same new substance was found by the late Prof. Woehler, the celebrated chemist of Göttingen, and a pupil of Berzelius, in a stone from the Ural Mountains called pyrochlore, which is also found in Norway; and more recently it has been met with in another rare mineral called monazite.

It was soon seen to be extremely difficult to smelt the metal out of the oxide of thorium, as we get iron or copper out of their oxides, by heating it to a very high temperature with coal or charcoal. However, Berzelius did manage to get out a minute quantity of the metal by other means, and obtained it as a metallic powder, not unlike lead in color and appearance. He found that when this metal was heated red hot in the air it took fire and burnt with a most extraordinary brilliancy. The light emitted was even more strikingly brilliant than that produced by the combustion of magnesium, which is at present so much used by photographers and makers of fireworks.

Now this light giving property of thorium is just bringing out this rare metal from the complete oblivion in which it has lain for nearly seventy years. While we are writing these few lines search is being made in many parts of the world for stones, rocks or sands which may perchance contain a certain quantity of this now precious substance, hitherto a mere useless chemical curiosity.

It has been found out, indeed, that of all the metallic oxides which have been tried on the so-called "hoods" or "mantles" that are placed around gas flames in order to increase the light, thoria is by far the finest; and of recent years the manufacturers of these "mantles" for the incandescent gas burners have created a brisk demand for thoria.

The consequence of all this is that, at various times during the last two or three years, a pound weight of this hitherto useless substance, thoria, has been freely sold at forty-five to fifty pounds sterling.

The incandescent light yielded by the "mantles" of thoria are enabling the street gas to rival the more expensive electric light; and employment in new fields is already being found for thousands of hands, thanks to the discovery, about seventy years ago, of a new substance, apparently of very slight interest, and long considered to be absolutely useless.

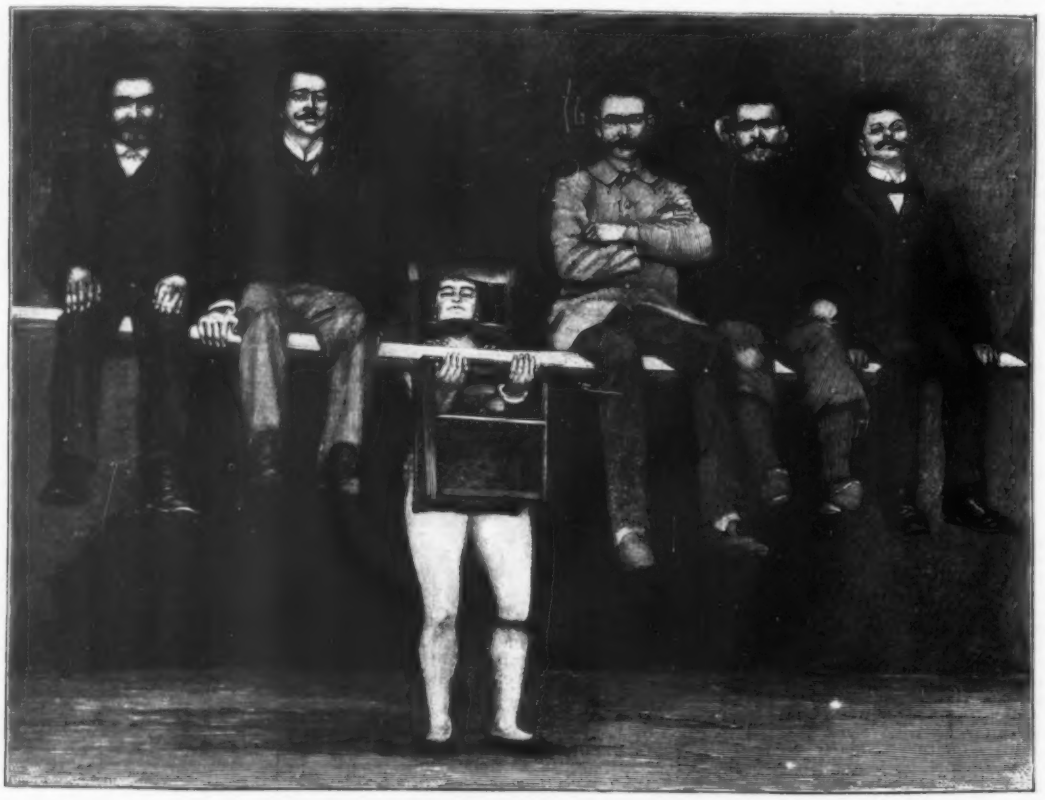
The minerals thorite, orangite, and pyrochlore, which all contain a large amount of thoria, are still very rare and expensive; but monazite has been found of late years in various parts of the world, and seems more plentiful, and as it generally contains about eighteen per cent. of thoria, it now forms the center of a new and rising industry.

However, this mineral, monazite, is by no means common. It is rather heavy, weighing about five times its own bulk of water. In several regions of the United States and Canada, principally near Quebec and in North and South Carolina, it is met with in the sand and gravel which form the bed of small streams, the richest deposits being usually found near the head waters, among the detritus of gneiss rock and schists, where it is associated with several other minerals. In such localities it is either seen in pure crystals—ranging in color from yellow to brown and yellowish green—sometimes as large as a grain of wheat or even larger, or as "monazite sand," in which minute crystals of the mineral are diffused or mixed with much ordinary sand and other worthless material. The principal district is North Carolina, the sands of which yield from two to four per cent. of monazite crystals. Similar sands are now being shipped from the coast of Brazil, which yield from one and a quarter to seven and a half per cent. of monazite. Some monazite sand also comes from Quebec. On the southern coast of Bahia it is found on a sandy beach of enormous extent, and is now being shoveled up from this beach into small vessels of some four hundred to five hundred tons and of light draught, and shipped to England or Hamburg. Norway is also supplying a certain quantity of the minerals thorite and orangite, which are very rich in thoria. About one ton weight per annum of these thorium minerals, representing seven thousand pounds' worth of thoria, is the present output from the south of Norway.

Soon after the introduction of the new incandescent gas burners the demand for minerals containing thoria increased to a considerable extent. The first offered were the Norwegian thorite and orangite ores, which contained from forty to sixty-two per cent. of the rare oxide. At first the price paid for pure oxide of thorium was as high as fifty-three pounds for one pound weight avoirdupois; but it has since oscillated very much, and has sometimes been as low as seven pounds per pound, according as the output is more or less plentiful.

We have, perhaps, said enough to show that a new and highly interesting branch of industry has arisen in a most unexpected manner, from a chemical discovery which, at the time it was made, and ever since, has been generally regarded as one of the most useless and least promising, from a commercial point of view, in the whole annals of scientific research.

*From Knowledge.



MISS ARNIOTIS IN THE BERLIN WINTER GARDEN.—FROM A PHOTOGRAPH BY J. BARUCH.

MISS ARNIOTIS IN THE WINTER GARDEN IN BERLIN.

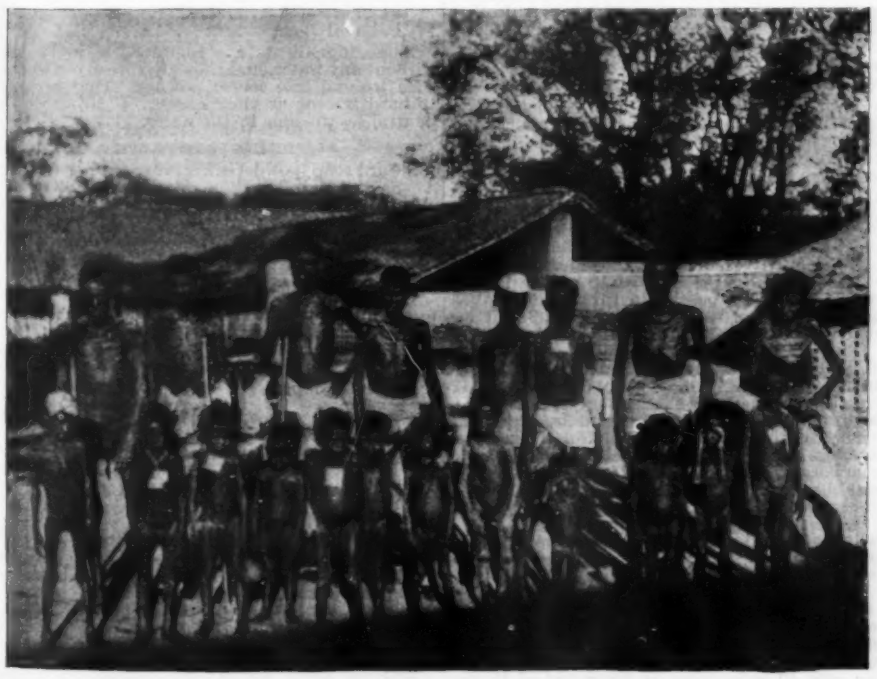
ANY ONE who has seen the feats performed by Miss Arniotis in the Berlin Winter Garden must have entirely changed his conception of the powers of the "weaker sex." This lady is attractive and pleasing in appearance and without any such superfluous development of muscle as athletes usually display. She strikes one as being a well-proportioned and pretty representative of her sex, but nevertheless her achievements prove her to be capable of performing at least half of the celebrated "labors" of the mythological Hercules.

With both hands she holds up a chair against which one end of a long board is placed, a man climbs up this board to the chair, places the board in a horizontal position and rocks back and forth without causing the bearer to show the slightest sign of weakening. An empty beer cask is rolled in and the athlete takes it between her teeth and carries it about for some time with two men seated on it like a double modern Bacchus. But her greatest feat was that of supporting five men and a boy on a board laid across a chair. This caused a sensation in sporting and athletic circles and was received by the public with great applause. It has been said that this phenomenon is to be made an honorary member of a men's athletic club in Berlin; which will help to solve a question that has been discussed much of late, but was not considered by the last Woman's Congress in Berlin.—Illustrirte Zeitung.

THE INDIAN FAMINE.

DESPITE the value of India to Britain, that vast possession is so far away that folks at home, as a rule, are scarcely in a position to appreciate the horrors of the famine which now darkens the land. Our illustrations will help to bring home to your minds some idea of the terrible sufferings that have been endured by the natives of late. It is on this ground alone that we justify the appearance of these ghastly pictures with their emaciated figures. Think of the pangs of hunger which must have been borne by the poor creatures ere they were reduced to a condition of skin and bone, and you will not think of blaming us for harrowing your feelings. The latest returns, which are necessarily incomplete, show that considerably over half a million are now in receipt of relief, and indicate that the number is steadily on the increase. Of the total mentioned the distribution is as follows: Northwest Provinces and Oudh, 336,230; Central Provinces, 45,900; Rajputana, 39,000; Bombay, 36,000; Bengal, 34,100; Burma, 29,000; Madras, 26,200; Central India, 7,500; and Punjab, 6,400. During the past few days some rain has fallen in several districts and there is the prospect of more. That the famine may speedily end must be the sincere wish of all. We are indebted to the English Black and White for the cuts and particulars.

SKIN AND BONE.



CERTAIN STARVING NATIVES.

IN FAMINE STRICKEN INDIA.—FROM PHOTOGRAPHS BY JOHN BLEES.

MENTAL OVERSTRAIN IN EDUCATION.*

By G. E. SHUTTLEWORTH, B. A. Lond., M.D., M.R.C.S. Eng., etc., formerly Medical Superintendent of the Royal Albert Asylum, Lancaster.

IN venturing to make a few remarks upon a somewhat trite subject I must plead as justification the fact that, notwithstanding much that has been said and written in the way of warning by men more experienced than myself, there still exist indications of a tendency to mental overstrain in certain departments of education. In the consideration of the subject it may be well to clear the ground by discussing the questions (1) What is education? and (2) What is meant by educational over-pressure, or such pressure in education as is likely to result in mental overstrain? and (3) finally, to inquire into the incidence, the etiology, and the signs of such over-pressure. A few words may follow as regards prevention and treatment.

To answer the question, What is education? it may be useful to consider what it is not. With some so-called educationalists I fear the idea still lingers that it consists of cramming a mind with as much of as many subjects as possible. Our laughing philosopher Mr. Punch has, however, very truly observed that "you cannot ladle grammar, arithmetic, and geography into a child's brain as you would brimstone and treacle into his stomach;" indeed, a smattering of philology will serve to show that the word "education" means not "putting in," but "drawing out." And, bearing in mind the physiological interdependence of bodily and mental development, we may say that true education consists in processes of training which will produce in a given individual the most favorable evolution possible of all the faculties both of body and mind. A rational educational system will of course recognize the fact that children are not cast in the same mould, that there are inherent—often inherited—differences in each pupil's powers, and that to attain the best results instruction must be adapted to idiosyncrasies and proportioned to varying capacities. Moreover, the comprehensive and far reaching character of education must be borne in mind, including as it does—as Paley puts it—"every preparation that is made in our youth for the sequel of our lives." From the medical standpoint, indeed, we shall reply in the affirmative to the query of Plato, "Is not that the best education which gives to the mind and to the body all the force, all the beauty, and all the perfection of which they are capable?" Over-pressure in education may in brief be described as a neglect of the principles just set forth—a neglect which cannot fail to lead to mental overstrain. Thus a cast-iron code imposing for each year of age a definite standard of acquirement, heedless of the varying capacities of children, could not fail to produce it. A disregard of physical conditions underlying mental evolution and of critical epochs of development (especially in the female sex) affecting capacity for exertion is another efficient cause. And the undue excitation of the unstable nerve cells of a child of neurotic heredity to such a pitch of activity as might be harmless in a normal child will in the case of the former be apt to constitute overstrain. Over-pressure, indeed, is not an absolute quantity, but has to be estimated in relation to the personal factor in each case. It may, therefore, be defined in terms of educational work as that amount which in a given case is likely to produce excessive strain of the physical or mental system, or both.

We pass now to the consideration of its incidence. Since 1870 every young Briton has been compelled to submit to educational processes of some description or other between the ages of six and thirteen. School attendance is, however, allowed to count toward a grant from the early age of three, and in some schools there are what are called "babies' classes." Formerly the leading idea with regard to these poor juveniles was that the function of school was to teach them to sit still, regardless of the incessant impulse to movement which characterizes all healthy young animals. Charles Kingsley long ago satirized the "foolish fathers and mothers who instead of letting their children pick flowers and make dirt pies, as little children should, kept them always working, working, working . . . till their brains grew big and their bodies grew small and they were all changed into turnips with little but water inside." And in days not far distant we have heard of hydrocephalus as an alleged product of mental overstrain in early years; indeed, it is reasonable to conclude that, where a proclivity to tuberculosis exists, cerebral hyperæmia and the stuffy, germ laden atmosphere of certain schoolrooms may conduce to tubercular meningitis. To-day a more enlightened view obtains as to the treatment of infants; and the educational department now officially directs the fostering of "the spontaneous and co-operative activity of such scholars." The musical drill, kindergarten games, varied occupations, and other exercises now so much in vogue in infant schools, are no doubt extremely beneficial, and with sanitary safeguards the infants in our elementary schools are better off than they would be at home. Although precocious children are sometimes injured by being pushed into prominence, it is not in the infant schools that we shall often meet with instances of overstrain. Nor is there nowadays, I think, so much evidence of over-pressure in elementary schools for boys and girls as was noticed some twelve years ago by our distinguished confrère, Sir James Crichton Browne. At that time he proved to his own satisfaction (if not to that of the education department) that more than one-third of the children attending elementary schools in London suffered from habitual headache (53·3 of the girls and 40·5 of the boys). He argued, moreover from the increased prevalence of nervous disease in children—and he cited in support of his argument the increase since the passing of the education act in the juvenile mortality from encephalitis, from diabetes, from kidney and rheumatic diseases (claiming these affections as "diseases with marked nervous affinities")—and from the frequency with which he had met with chorea, with stammering, and with neuralgia in school children examined, that over-pressure certainly existed in connection with compulsory education in elementary schools. In those days it would seem to have affected most severely the backward children, classified by Sir James Crichton Browne as either "dull, starved, or delicate," the code requirements of that date conducing to the whipping up as far as possible of all children to definite age standards. Happily, grants are no longer made on the percentage of passes in standards arranged according to age, but after examination of the scholars by sample. Her Majesty's inspectors are also authorized to ask the teacher to select a few of the best children for examination in the several subjects, so that the tendency now is not so much to press unduly the dull children as to work up the brighter children to a point that shall dazzle the inspector. Unfortunately, bright, precocious children are not unfrequently the offspring of a neurotic stock, and it is just these that are likely to break down under emotional excitement and the pressure of an examination in prospect. From all I have been able to gather from teachers and from the children's hospitals in London, it would seem that it is this class that nowadays furnish cases of school headache, of chorea, and other nervous affections, more particularly about the periods of examination. In secondary education the incidence of over-pressure would seem to be more marked in the preparatory schools than in the public and other schools for senior boys. This is probably an instance of the "survival of the fittest," and there is much reason to fear that not a few promising boys, approaching the trying epoch of puberty, are sacrificed to the Moloch of competitive examination for entrance scholarships. I do not say that in schools for senior boys there is no over-pressure, but in the great public schools and others following their methods the tendency to brain strain is counteracted by a goodly proportion of outdoor exercise and physical exertion in the way of games. Happily, schools of the type of Dr. Blimber's satirized by Dickens as "a great hothouse in which there was a forcing apparatus constantly at work, and mental green peas were produced at Christmas and intellectual asparagus all the year round," are not so common as formerly.

With regard, however, to secondary schools for girls I fear that it is impossible to speak with favor of the hygienic aspects of the system pursued in many of them. In fierce emulation of methods formerly designated "propria quæ maribus," some at least of the high schools for girls seem to have overlooked the physiological conditions and necessities of budding womanhood. It has been well remarked that "puberty with girls is a period of profound nervous and neuro-psychological import. . . . Many a weak woman could, if she only knew, trace back her weakness to an overstrain at this period of life." It is most unfortunate that too often there is a tendency (for which parents equally with teachers are responsible) to subject to serious and exhausting study girls of from twelve to fifteen years of age, just at an epoch when they should have the minimum of school-room work and the maximum of out-door exercise and recreation. The rapid growth and development which occur at this period and the physical changes concerned in the establishment of the menstrual function constitute a drain upon the girl's organism, leaving little reserve of strength for arduous mental exertion. What, however, do we find is the actual curriculum of high school girls at this age? Four hours' almost continuous work in the morning, exclusive of extra subjects in the afternoon, with a minimum of from two to three hours' preparation in the after part of the day. And to this is superadded time necessarily devoted to the practice of music and other feminine arts. Where, on a winter's day at least, is proper exercise and recreation to come in? The public school boy has at least two hours' compulsory play (usually in the open air) during the afternoons: it is the exception, I believe, at girls' high schools to have anything so plebian as a playground, and I know of

* A paper (taken as) read in the Section of Psychology, British Medical Association annual meeting, July 31, 1896. From the London Lancet.

one where a well-equipped gymnasium exists, but is never used for gymnastic exercises properly so called. The morning interval, nominally of ten or fifteen minutes, is not usually spent in brisk exercise in the open, as would be the case with boys, but in munching buns, or nibbling biscuits, or, at the best, in perambulating corridors with arms entwined around companions' waists after the manner of females. Is it to be wondered at that as the term proceeds the roses we have been used to associate with English maidens' cheeks gradually fade and signs of nervous exhaustion show themselves? Dr. W. S. Playfair remarked in a paper* read at the last annual meeting of the British Medical Association that some high school mistresses seem to hold the view that in relation to education the menstrual function may be ignored; and he gave an instance in which the head of one of the colleges for girls had written to the medical father of a broken-down pupil saying that they —i. e., the college authorities—considered that "the menstrual function was not of consequence, and that when it was in abeyance for a time it came all right afterward when the girls left school"—a sentiment rather reminding one of the story of King Canute and the flowing tide!

In these three points then—(1) excessive hours of study, especially during spurts of growth and development; (2) deficiency of systematic out-door exercise and recreation; and (3) disregard of physiological functions differentiating the capacity for work at certain times of girls as compared with boys—I think the high school system needs amendment. In women's colleges of the type of Girton, Newnham, and the Royal Holloway there is more elasticity in the curriculum and a certain safeguard against over-pressure in the way of out-door sports. Even there, however, there is risk in the frequently recurring examinations, which are taken more keenly and conscientiously by young women than by young men of corresponding age; and with those of bad heredity especially there is a tendency to break down under the strain of competition. During the last year I have had under my observation the case of a girl aged nineteen, a student at a women's college, whose health completely gave way under pressure of the Christmas "trials" (as the terminal examinations are appropriately called) which unfortunately coincided with a menstrual period, and the patient being of neurotic tendency, developed decided symptoms of nervous exhaustion.

We may now briefly consider the etiological factors of mental overstrain. First and foremost come a neurotic family history and predisposition to tubercle. So far as I have seen, signs of overpressure are rarely met with except when there is such morbid heredity, whether in elementary or in secondary schools. Secondly, malnutrition. In elementary schools there is no doubt that over-pressure often means under-feeding, and even with scholars of the better social grades emaciation consequent on shirking of meals predisposes to mental breakdown. So, as Burns' grace expresses it,

"Some hae meat that canna eat
And some wad eat that want it."

Thirdly, in the female sex, disorders of the menstrual function causing irritability and deficient powers of application. The influence of pernicious practices during the period of sexual development in the case of boys (and, indeed, with both sexes) must not be overlooked. Finally, with one or other of these predisposing factors we have the exciting influence of overstimulation of brain cells, resulting in subsequent exhaustion.

Among symptoms noticed we may specify the following. In young children a weary, preternaturally old look, to which the furrowed forehead, knitted brow, bagginess around the eyes, and sallow complexion all contribute. A general fidgetiness and irritability—sometimes muscular twitchings especially seen about the angles of the mouth—are noticed; and there is a general want of tone and balance about the muscular system, so that the hand when extended assumes a feeble pose and we may often see or feel finger twitches. In more severe cases actual jactitations of the limbs occur and the symptoms pass, especially with girls, into well-marked chorea. Headache is frequent and an habitual attitude is with the hand pressed against the brows; sleep is, as a rule, disturbed. With young children transient nocturnal hyperpyrexia is not infrequent, and night terrors sometimes occur. In some cases the tongue and lips are tremulous and speech is stammering. There is, as a rule, evidence of digestive disorder, such as foul tongue and fetid breath; often we find a distaste for wholesome food, sometimes a perverted appetite, and an over fondness for sweets. In pubescent boys and girls the neurasthenic symptoms tend to be more marked, such as incapacity for sustained attention (aprosexia), feebleness of memory, a tendency to answer exactly opposite to what is known to be correct (heterophemia), neuralgia, and (in girls) hysteria, sleeplessness or sopor, a want of pluck and general apathy. These symptoms are often associated with such physical signs as a sallow, earthy complexion, anæmia, constipation, and what has been designated "anorexia scholastica." Aversion to solid food in the early part of the day is a frequent symptom, with a tendency to substitute nerve-titillating tea for more nourishing diet, and (as we have seen) it is not only from want, but frequently from want of appetite, that overpressed children go to school minus their breakfast. I have myself had the opportunity of watching a high school girl, naturally of good physical as well as mental development, whose morning appetite, vigorous at the beginning of term, becomes small by degrees and miserably less as work presses and the examination period approaches. And on inquiry as to the causes of breakdown of the student at the women's college referred to, I found that though the principal meals were served in the hall, the more studious were apt to shirk the solid viands and whip up their flagging powers with tea, made (ad lib.) in their own rooms.

A few words on prevention and treatment must close this paper. As regards prevention, much rests with the parents themselves, who are but too apt to shirk responsibility and throw all blame upon the teachers. The poorer classes have indeed but little option as to the sort of education to which they will subject their children, the education department acting the part of Providence in prescribing the curriculum. But it has not always been a wise Providence, and its decrees might have been at times more judicious had it been able to avail itself of the assistance of a competent medical adviser. It is a hopeful sign that many of the larger school boards have appointed medical officers, and as their opportunities of influence increase we may look for an improvement not only in the hygiene of schools but of educational systems. Parents of poor children should, however, themselves make a vigorous stand against home lessons and undue detention, the most common causes of over-pressure in elementary schools. As regards secondary schools, parents have more in their own hands. It is indeed hard to resist the fashion of the day, but it is clearly the duty of medical men to protest against anti-physiological practices in schemes of education. Parents who know or who are advised that their children are of unstable nervous temperament must beware of the dangerous strain of competitive examinations in such cases, especially at critical epochs of development. Much may be done by favorably regulating the home environment of children attending day schools in the way of punctuality at mealtimes, insistence on sufficient out-door exercise and ample hours of rest, a point being made of going to bed early. Of course, with overstrain as everything else, the rule of action should be "obsta principiis," and warning signals, however slight, should not be disregarded.

The condition precedent to successful treatment is naturally the withdrawal of the pupil from conditions known to be injurious, even at the loss of a term's schooling. A term's brain rest is not always time wasted, and to wait for the full development of threatening symptoms is fatuous policy. The late Dr. Octavius Sturges gave (in a paper read at the International Congress of Hygiene, 1891, vol. x, p. 20) the pitiable history of five cases of what he designates as "school-bred chorea." These poor children having been kept with their "noses to the grindstone" in spite of morbid restlessness, the significance of which was not appreciated by the teachers, "were only removed from school when St. Vitus' dance had developed so fully as to render them absolutely incapable of schoolwork and sometimes even of speech." Had those in charge been aware of the "hand test," so easily applied, timely relief might have been given and the worst symptoms averted. As to treatment, one may say, in a general way, use all means that will invigorate the body and cheer the mind. "A change" is often recommended, but let it be a change with an object, for nothing is worse in mental overstrain than inactivity and leisure for morbid introspection. Physical exercise in some congenial form and taken in moderation (e. g., bicycling, boating, golf, tennis, or skating) may be of great value in restoring the balance of the circulation. A course of light literature is frequently of advantage, and an interest in artistic or manual work, such as painting or wood carving, or, what is still better, some outdoor occupation, such as gardening, may be of signal service. Time does not permit of the discussion of drug treatment (the indications for which will vary in different cases); but, as a rule, it may be said that, having quickened the sluggish excretory functions by due purgation and broken bad habits of insomnia by a short sedative course of sulphonal or paraldehyde, ferruginous and nervine tonics are of value. Nutrition being often much impaired, a course of massage and feeding on the Weir Mitchell system may be of service in extreme cases, and, as a rule, the administration of cod liver oil, maltine, etc., is beneficial as conducing to that comfortable condition of body which, according to Dr. Clouston and other evangelists of the "gospel of fatness," is distinctly favorable to mental contentment.

Richmond Hill.

* Brit. Med. Jour., Dec. 7, 1895, p. 1408.

In the entire kingdom of Italy it is estimated, says the Engineer, that there are now 6,303 mechanical and 3,685 hand looms, without counting the small hand looms at the homes of the operators. The most important woolen factory in Italy, according to Consul Bright, of Catania, is that at Schio, with 2,200 operatives. The mills of Italy number 431, with 121 steam and 406 hydraulic motors, and give work to 30,240 operatives; the spinning and combing mills number 11, with 2,258 operatives, of which the oldest and most important is that of Borgosesia, with works for dyeing, weaving, and other purposes. In threads of combed wool the production of the country is insufficient for the demand of the weaving and knitting establishments. There exist in Italy, as stated above, 6,303 mechanical and 3,685 hand looms, or in all 9,981, besides the smaller home looms. The Society of Arts Journal, estimating the production of each loom at 10,000 lire, gives the total annual value of 99,880,000 lire of Italian production. Adding to the 34,653,355 lire as representing the value of the woolen tissues introduced into Italy from foreign countries, and the total value becomes established at 132,553,555 lire.

The following is a statement of the centers of population in the United States for one hundred years, at each decennial, prepared by the census office for the World Almanac and Encyclopedia, 1896: 1790, 23 miles east of Baltimore, Md.: 1800, 18 miles west of Baltimore, Md., west movement 41 miles; 1810, 40 miles northwest by west of Washington, D. C., west movement 36 miles; 1820, 16 miles north of Woodstock, Va., west movement 50 miles; 1830, 19 miles west by southwest of Moorefield, W. Va., west movement 39 miles; 1840, 16 miles south of Clarksburg, W. Va., west movement 55 miles; 1850, 23 miles southeast of Parkersburg, W. Va., west movement 55 miles; 1860, 20 miles south of Chillicothe, Ohio, west movement 81 miles; 1870, 48 miles east by north of Cincinnati, Ohio, west movement 42 miles; 1880, 8 miles west by south of Cincinnati, Ohio, west movement 58 miles; 1890, 20 miles east of Columbus, Ind., west movement 48 miles. Total westward movement in 100 years, 505 miles.

Gaillard, printer, of Nimes, has obtained a reputation by his fine posters and notices. It appears that these notices are printed with linoleum. The drawings are made on linoleum, which is then cut with the scissors or knife; the pattern is afterward glued to wooden blocks. For these purposes wood, celluloid and clay have chiefly been used as yet.

SELECTED FORMULÆ.

Washing Powder.—A German soap journal gives the following processes:

Figged (soft) soap	25 lb.
Linseed oil soap	20 "
Soda ash	65 to 70 "

The above are crutched together, whereby the mixture becomes heated; the mass is then turned with a spade at short intervals until it disintegrates in small pieces. After cooling it is rubbed through a fine sieve and the powder is then ready to be packed. This process is recommended for small businesses, as it requires no mill to be used.

For large quantities the boiling process is better adapted, but it requires the use of a mill. Here is the formula:

Red oil	350 lb.
Soda lye, 40° B	140 "
Soda ash	70 "
Water	280 "

After saponifying the above and shutting off the heat, add 350 pounds soda ash by constant crutching. By continuing the crutching a gritty mass is obtained, which is run into a wooden, tin-lined box about 12 in. high, and there still crutched till cold. Recently soap powder has been brought on the market with an odor of ammonia, tupentine, and sometimes also perfumed. These ingredients may be incorporated while stirring in the box. On cooling, the now very solid mass must be ground in the mill and sifted. Powder carefully made in this way, it is said, does not expand while stored, and the bursting of the packages is not to be feared.

A cheaper powder is made by the same process from the following:

Palm kernel oil	135 lb.
Palm oil	20 "
Soda lye, 40° B	100 "
Water	800 "
To which are added soda ash	1,050 "

Gathmann (American soaps) says that washing powders, usually sold to the consumer as soap powders, may be described in a general way as mixtures of powdered soap with about its own weight, more or less, of carbonate of soda. Some special brands are made which, in addition, contain other detergent agents, such as carbonate of ammonia, sal ammoniac or borax, while still others are found to which filling, in the form of talc, silex, etc., has been added. The soap itself may have been made by any of the processes known—cold, half boiled, or boiled, settled or boiled down—and the stock used may have been any fat, or mixture of fats, according to the grade of the washing powder to be made. It is thus seen that beyond being either principally or entirely a mixture of soap and soda, these powders have little in common with each other. Here are some typical formulas:

BORAX SOAP POWDER.

Curd (hard) soap, in powder	5 parts.
Soda ash	3 "
Silicate soda	2 "
Borax	1 "

Each ingredient is thoroughly dried and all mixed by sieving.

LONDON SOAP POWDER.

Yellow soap	6 parts.
Soda crystals	3 "
Pearl ash	1½ "
Sulphate of soda	1½ "
Palm oil	1 "

These ingredients are combined as well as possible without any water, and they are spread out to dry, and then ground into coarse powder. They are adapted to hard waters, as their excess of carbonated alkali neutralizes the lime in the water.

PEARL SOAP POWDER.

Curd soap (powdered)	4 parts.
Sal soda (crude sodium carbonate)	3 "
Sodium silicate	2 "

Dried as much as possible and intimately mixed.—Pharm. Era.

Black Inks for Rubber Stamps.—

For general use:

Tannin, black	1 part.
Water	1 "
Glycerin	2 "

Mix.

For textile fabrics:

Nigrosin	2 parts.
Methyl violet	4 "
Water	5 "
Wood vinegar	5 "
Alcohol	5 "
Glycerin	35 "

Mix and dissolve.

—Bayerisches Indust. und Gewerbeblatt.

Madam Ruppert and Her Face Bleach.—The Western Druggist furnishes the following particulars in regard to this subject:

Mercuric chloride	8 grs.
Tinct. benzoin	1 fl. dr.
Rose water	8 "

Japanese Secret Alloys.—The following is the composition, according to the Iron Industry Gazette, of a number of Japanese alloys hitherto kept a close secret, and now revealed by workmen making them. The "shadko" is an alloy of copper and from 1 to 10 per cent. of gold; the objects are placed in a mordant of sulphate of copper, alum and verdigris until they have assumed the coppered or blue black hue of swordsheaths and decorative articles. "Gni-shi-bu-ichi" is a copper alloy with 30 or 50 per cent. of silver of the well known gray color. "Mokume" is a compound of several alloys. About 30 plates of foils of gold, "shadko," copper, silver and the last mentioned alloy are soldered together, holes are made, the plate hammered out and put in the mordant. The finest Japanese brass, "sinchu," consists of 10 parts copper and 5 of zinc. Bell metals, "karakane," are made of 10 parts of copper, 4 tin, ½ iron, 1½ zinc, the copper being melted first, and the other metals added in the above order. Other proportions give inferior bell metals.

ENGINEERING NOTES.

The first notice of the use of coal is in the records of the Abbey of Petersborough, in the year 850 A. D., which mention an item of twelve cartloads of "fossil fuel."

A man in England is introducing a wax wire for venting cores, says the American Machinist. The wax wire is embedded in the cores while they are being made, and in drying the core the wires melt and are absorbed by the sand, the channels thus being left free and clear. Being made in sizes from $\frac{1}{32}$ to $\frac{1}{2}$ inch in diameter, the wax wire is suited to almost any kind of work, and being perfectly flexible it can be used in the most complex and difficult work, while the cost is not prohibitive.

It is stated that the constructor of the Siberian Railway, M. Michailowski, has been asked to undertake the building of the new Chinese Eastern Railway through Manchuria. The new line will start from a point on the Onon River, where the Trans-Baikal line touches it, will cross the Chinese frontier at Staro-Tsurukhaitu and pass through the towns of Tsitsihar, Khu-lanchen and Ninguta. Its terminus will be Nikolskaya, on the South Ussuri line. The total length of the new line will be 1,920 versts, 1,425 of which lie in Chinese territory.

The revenue from all sources (including patent royalties) of the Pullman Palace Car Company in 1895-6 was $9,244,383, as compared with $8,547,625 in 1894-5, $9,595,067 in 1893-4, and $11,389,896 in 1892-3. The company distributed in dividends for 1895-6 $2,880,000, as compared with $2,880,000 in 1894-5, $2,880,000 in 1893-4, and $2,520,000 in 1892-3. The surplus carried forward from 1895-6 was $1,647,409, as compared with a corresponding surplus of $1,410,391 in 1894-5, a corresponding surplus of $2,330,417 in 1893-4, and a corresponding surplus of $4,006,448 in 1892-3.

Mr. W. C. Kerr, says, in Cassier's Magazine, that in the tempering of steel or the cooling of other articles in a bath of special composition of such cost that it cannot well be run to waste, as oil or brine, the necessity arises of removing the heat surrendered by the material cooled, thus keeping a constant temperature in the dipping tank. In the case of saw tempering, a large volume of brine is refrigerated and circulated through the dipping vat. The large reserve volume acts as a fly wheel, equalizing the fluctuations of temperature arising from varying rates of dipping, the compressor running continuously.

In a recent report made to the Canadian Pacific Railroad Company by one of its engineers of some tests of various kinds of steam lagging, the following table was included, showing the loss of power that had been found to take place from uncovered pipes filled with steam at seventy-five pounds gage pressure:

2	in. pipe,	1	h. p.	loss for every	132	ft. of length.
4	"	1	"	"	75	"
6	"	1	"	"	46	"
8	"	1	"	"	40	"
12	"	1	"	"	26	"

About 90 per cent. of this waste, it was added, can easily be prevented by a proper covering of the pipes. When it is considered that this loss occurs at the comparatively low pressure of seventy-five pounds, it is apparent that with steam at one hundred and thirty pounds and one hundred and forty pounds and higher, the loss becomes very serious.

In the forest of the Bridal Veil Lumbering Company, at Bridal Veil, Oregon, not far from the Dalles, there is a railroad which does business without cars. An article in the Northwestern Lumberman, describing the work of this company, has a picture of a "train" on the road, which consists of an ordinary locomotive such as are common on logging roads, and a string of logs, each log being as large in diameter as the boiler of the engine or larger. Boards are nailed to the sleepers between the rails, and on these the logs slide. Except on descending grades, the boards are greased, and the train moves at good speed. Where the road is level or slightly ascending the engine pulls the logs, and where it is descending it holds them back. At the mills of this company the manufactured lumber, regardless of size, is run into a flume and this is carried about two miles to the planing mill and shipping yard, the flume descending in that distance about 1,200 feet.

An Imperial edict has lately been issued in China authorizing the building of a line from Peking to Hankow and from Hankow to Canton. This means a line of 1,150 miles—the distance from Peking to Hankow being 650 miles and from Hankow to Canton being about 500 miles. A recent issue of the North China Herald states that Shêng, who has been made director of the new railway board, is of the opinion that it would be better for China to begin by building short remunerative lines within the limits of her own resources, rather than set to work on large schemes with borrowed money. But China has not the same aversion to incurring debts that she had a quarter of a century ago. She speedily raised on loan the money needed to pay Japan, and she is now having offers on all sides to provide loans wherewith to construct a railway system. It is understood that American offers of financial aid have been accepted, and that Shêng some months ago arrived at an arrangement with a syndicate known as the Wharton-Barker.

A submarine boat for wrecking and exploring purposes is about to be built by the Columbian Iron Works, of Baltimore, after the plans of Mr. Simon Lake, a Baltimore inventor. The practicability of the design, it is stated, has been proved by experience upon a small boat. The boat will be capable of rising to the surface and submerging at will, and it may be propelled in any desired direction when on the bottom. A door may be opened, through which the occupants, by donning a diving suit, may pass from the interior to the outside and back again. The boat will be used principally for searching the bed of the ocean adjacent to coast lines, and in locating and recovering sunken vessels and their cargoes. It will be about fifty-four tons displacement, and will carry a crew of six men. It will be propelled while on the surface by an engine and screw of the ordinary type, and while under water the screw will be driven by an electric motor, taking current from storage batteries. A searchlight will light the pathway of the vessel as she moves along the bottom.

ELECTRICAL NOTES.

It is estimated that to build the telephone line from Eastern Washington to Puget Sound points it will take 16,000 poles, 1,884 miles of No. 10 hard drawn copper wire, 15,000 cross arms and braces and 32,000 pins and insulators. The estimated cost of material and labor is $72,000.

The International Telegraph Bureau, in Berne, has recently published a very fine chart giving all the land and sea telegraph lines of the world used for through messages. It is correct up to July 1, and the various lines are indicated in different colors. It is furnished for the nominal sum of six cents.

A big crane at Kiel (Germany) has been fitted with an electro motor. It was formerly operated by hand, and four men had to work two hours to raise a load of 15 tons, their wages amounting to 2·88 marks (about 70 cents). Now the same work is done in four and a half minutes, and the current required costs only 17 pfennings (4 cents).—Elektrotechnische Rundschau.

Work was begun on December 21, 1896, to construct the third rail electric system between Hartford, Conn., and New Britain. Workmen were out that date on the line of the New England road taking measurements preliminary to bonding the rails and laying the third rail. The removal of buildings that stand where the big power house is to be located in Berlin was started recently. Electric cars will be running on the roadbed of the steam railroad by March 1. The cars will be the same as those used at Nantasket Beach.

The Engineer gives in a recent issue an exhaustive description of H. M. S. Prince George. From this description we cull the following particulars: Six search lights are carried, and the interior lighting is effected by 930 glow lamps, one-third of which are 50 c. p. lamps and the remainder 16 c. p. There are 29 miles of electric light cable aboard the Prince George. Electricity is also employed as an auxiliary in training the four 12 in. wire guns, but apparently is not made use of to drive ventilators or to hoist shot and shell. Current is supplied by three 600 ampere dynamos.

The total capital invested in electrical industries in the United States is said to be over $2,000,000,000. Electric railways, says a writer in Cassier's Magazine, are represented by a capitalization of over $700,000,000. The number of trolley cars in use is said to be over 25,000, and these on over 12,000 miles of track. The electric railways represent more than 90 per cent. of all the street and suburban railroads of the country. The aggregate of all the capital invested in electric lighting, electric railways and electric power is about $1,500,000,000, and this does not include the value of the establishments that manufacture the machinery and apparatus. Inasmuch as the electric light and power industry represents an investment of about $1,500,000,000, without counting the value of the concerns that manufacture the machinery and supplies, it is evident that to estimate the total investment in every department of the electrical industry at $2,000,000,000 in the United States alone is not extravagant, for this would allow only $500,000,000 to cover the value of the telegraph, the telephone and the almost unlimited number of electrical manufactories, large and small, that can be found from one end of the land to the other.

The advisability of securing for a large electric lighting or power station a location on a water front, where an abundant supply of water may be had for condensing purposes and where coal may be received and ashes shipped away on boats, has once more been brought to notice by the announcement of an extensive project by the Edison Electric Illuminating Company, of Brooklyn, says the Engineering News. It has recently purchased a shore front property at Sixty-sixth Street, Brooklyn, measuring 260 ft. on the water front and 1,150 ft. in depth, of which 550 ft. is under water. It is the intention of the company to construct there an electric central station, which will be one of the largest and most economically operated plants of its kind in the world. On the land under water two piers, 60 × 550 ft. each, will be built for handling and storing coal. From the bulkhead line back, a one-story brick building will be erected, which will contain boiler and engine rooms. The engine room will also contain the dynamos and other electric apparatus. The new station will be put in connection with the other stations of the Edison Company, and, in addition, will run connections into each sub-district of the city and to surrounding suburban towns as far as Babylon, Roslyn, Garden City and Hempstead. Underground conduits will be used for transmission.

Electric car lighting is now used on the express trains of vestibuled corridor cars being run by the Southeastern Railway between London, Hastings and St. Leonards. Each train has five cars, each 50 ft. long, mounted on four wheel trucks. There are 16 lights in the car, including one in the lavatory and three in the smoking room. Each car has its own dynamo and accumulators, the dynamo being driven by a 2¼ in. link belt from a pulley on one of the axles. The novelty in the system is the means of getting constant voltage independent of the speed at which the train is going. Instead of allowing the speed of the dynamo to vary and regulating the magnetic field to correct for this, the dynamo is suspended so that its weight gives the necessary tension to the belt. The weight of the machine and the torque on the armature then exactly balance each other at the normal output. Any further effort causes the dynamo to be pulled nearer to the driving axle. This slackens the belt and allows it to slip over the dynamo pulley. Thus a condition of equilibrium is reached, and a further increase of speed is impossible. The armature connections are reversed with a reversal of direction of rotation. An automatic switch, worked by a small governor on the shaft, closes first the shunt circuit and then the main circuit as the speed increases to the normal. The inverse operation takes place as the train slows up. The accumulators are placed in two wooden boxes under the middle of the car, one on each side. There are 16 of these to each car, the plates being contained in teak boxes. The dynamos on the car give about 35 amperes at full load. The lamps used throughout are of 10 c. p. at 30 volts, and are controlled from an attendant's recess. A switch turns on one-half or the whole of the lamps, as may be required.

MISCELLANEOUS NOTES.

About 2,500 yards of American moquette carpeting was used at the coronation of the Czar at Moscow. Since then the Empress of Russia has given an order for a very large quantity of American moquettes, Gobelins and Axminsters for the Imperial Palace at St. Petersburg.

Berlin had 211 grammar schools in 1895 and 46 high schools (where ancient languages are taught). The university and colleges are not included in this total. Of the 46 high schools, 37 are municipal, 6 of them being girls' schools.—Oesterreichische Monatschrift für den öffentlichen Baudienst.

The German exports of needles amounted to 1,079,100 kilogrammes during the first ten months of 1896, as compared with 640,300 kilogrammes during the corresponding period of 1895. The gain is due principally to a surprising increase of the Chinese trade, the figures for the first ten months of 1895 and 1896 being respectively 283,900 and 712,700 kilogrammes.—Uhland's Wochenschrift.

The "Gebrauchsmuster" is a very popular means of securing protection for inventions in Germany, as may be seen from the fact that during the first five years of the existence of this kind of protection 61,000 Gebrauchsmuster have been registered, while only 89,000 patents have been granted during the twenty years the patent law has been in operation in Germany. A Gebrauchsmuster is registered without examination as to novelty.

Book publishing seems to have reached a fixed limit in England, only sixty more books having been published in 1896 than in 1895, and only forty more in that year than in 1894. Last year 6,573 new books and editions were published, as against 6,516 in 1895, while the number of books published for the first time is 250 less than in 1895. The chief gains are in history, fiction, and poetry, while the losses are in travels, belles lettres, and miscellaneous works.

A comparison of the different manganese producing countries shows that Russia is not only the principal producer, but that its production increases every year. Russia produced, in 1894, 244,972 tons, while all other countries produced, in the same year, only about 193,000 tons. In 1895, Russia produced 248,000 tons. With the exception of Chile, France, Germany and Japan, the production of manganese ore has declined everywhere, especially in the United States. The American Manufacturer says this is due to the growing competition of the Caucasian and Chilean ores.

The annual output of petroleum in Roumania is estimated at 80,000 tons. Of this about a third is obtained from the wells of fewer than half a dozen miners, and the remaining two-thirds are got from the lands of about 120 small speculators. Barely 15 per cent. of the yield is exported across the border. As the population of Roumania is about 6,000,000, it becomes evident that the home consumption at present must be in its infancy; but as the supply is developed and improved the demand will greatly increase; for the Roumanian peasants have, as it were, to be educated up to the use of anything but the crudest forms of domestic lighting.

The increase of English speaking people is one of the notable phenomena of this century, says the Sanitarian. At present they are estimated to increase about 2,000,000 annually, and we have seen the whole number stated at 115,000,000, which we think is a low figure, as the 70,000,000 in the United States are about half that number, leaving Canada, Great Britain, Australia, New Zealand, and the other immense British possessions in the world to make up the balance. What is the connection between these facts and the spread of life insurance, which practically began with this century and has seen its greatest development in its last half? It was practically at zero in 1800; it exceeds $4,300,000,000 in the United States alone to-day!

Germany's export trade in arms and ammunition is in a very prosperous condition, owing to extensive armaments made by Turkey, China, Brazil, Chile, Argentina, and more recently, Spain. The exports of small arms amounted to $7,000,000 in 1895, about trebling the amount of the preceding year. The increase still continues, as the exports during the first four months of 1896 amounted to 658 metric tons (500 during the same period of 1895). China, Spain and Chile are the best customers at present. There is also an increase in the export of projectiles and cartridges, explosives, fuses and smokeless powder. One of the leading German gunpowder factories exported more than 42 per cent. of its production for the year.—Stahl und Eisen.

This year the annual exhibition of paintings and other works of art in Paris will be held for the last time in the Palais de l'Industrie in the Champs Elysées, as the building is to be torn down to make room for the 1900 World's Fair. In 1673 the show was held in the Palais Royal, where the Theater Francais now stands; in 1699 it was moved to the Grande Galérie of the Louvre, and in 1737 to the Grand Salon in the same building. There the exhibition was held for 122 years, till 1849, and acquired the name of "Salon," which it has retained since wherever it has gone, and which has been also taken by the rival exhibition of the Champ de Mars. For a few years it wandered about, being held in the Tuileries, the Palais Royal again, and in the old Hotel des Menus Plaisirs, but in 1857 it found a home in the Industries building of the 1853 World's Exhibition, where it has ever since been held.

The latest edition of the "American Newspaper Directory" gives a list of 1,123 newspapers in the United States which possess a circulation of 5,000 and over, the combined circulation being represented at 27,310,328. Of the Canadian papers 46 are said to have attained a similar circulation, the aggregate being 689,369. It is interesting to note that the class journals devoted to books, newspapers and periodicals number 35, and their combined circulation each issue is 70,895 copies. Architecture, contracting and building are represented by 43 newspapers, having a combined circulation each issue of 82,265 copies. The brewing, bottling, cider, liquor and wine interests are represented by 26 newspapers and periodicals. They have a combined circulation each issue of 31,295 copies. Advertising has 12 representative newspapers, with a combined circulation of 36,208 copies each issue.

CANET NAVAL GUNS.

THE Forges et Chantiers de la Mediterranée built for the Greek government, as long ago as 1889, three armored vessels—the Hydra, the Spetzia, and the Psara. Each of these was armed with three Canet 27 centimeter guns (10·63 in.); at that time the quick-firing class of the larger calibers had not been placed in service. Two years ago the Greek Minister of Marine announced the intention of increasing the armament of these ships, with the special view of obtaining greater power of defense against torpedo attacks, by the addition of quick-firing guns of small caliber, but of high velocity and of very flat trajectory. It was decided that this supplementary armament should consist of Canet 10 centimeter and 65 millimeter quick-firing guns, 50 calibers in length. The order for these guns was given during the last year, and those for the Psara have been delivered and accepted after very satisfactory trials. The 10 centimeter guns fire a projectile of 13 kilogrammes (28·6 lb.) and the 65 millimeter one of 4 kilogrammes. The materiel possesses several features of interest; it is illustrated by the various figures herewith, and the following is a description of the guns and mounting:

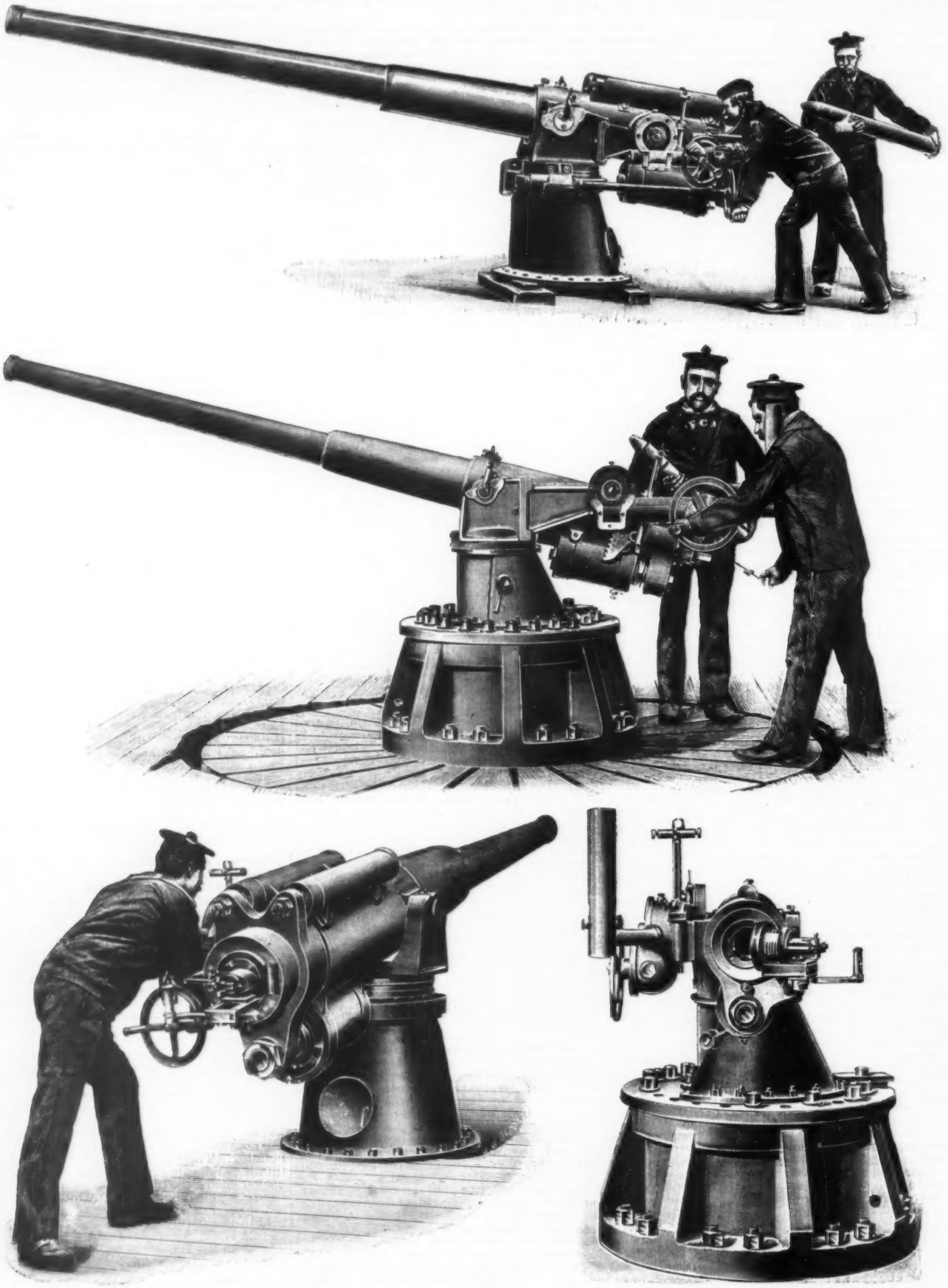
The supplementary armament for each of the three ships consists of one 10 centimeter and eight 65 millimeter guns; they are all 50 calibers in length, and are composed of the following parts:

(a) A tube that extends for the whole length of the gun, and in the end of which the screw seating for the block is formed.

(b) A sleeve over the rear portion of the tube, and the ring carrying the shoulder piece, and to which the piston rod of the brake is attached.

(c) A reinforcing sleeve over the forward part of the inner tube.

The breech mechanism is on the Canet system, and is operated by a single movement of the breech lever. The breech block, except when in place, is carried on a bracket, as is indicated in the illustrations. The various operations of turning the block so as to free it from its seat, of withdrawing it, and at the same time starting the cartridge, of swinging it clear of the breech, at the same time completing the extraction, are all performed by the movement of a lever in a horizontal plane, from left to right. The guns are carried in their mountings by trunnions which are formed on a ring placed on the gun, as shown in the illustration; around this oscillates the mechanism for vertical training, and below is the brake cylinder. On the upper part of the sleeve is placed the spring device for absorbing the energy of the recoil; this is independent of the brake mechanism, and serves to bring the gun back into firing position. The trunnions are carried in the side frames of the movable mounting. This part of the mounting terminates beneath in a central conical pivot that rests on a step bearing in the fixed part of the mounting. On the moving carriage are attached training devices both for vertical and horizontal directions. The lower, fixed mounting, which is attached to the deck, is made with a conical recess to receive upper and revolving part; in the bottom is placed the step bearing on which the system turns. On the upper part of the fixed mounting is a ring guide that steadies the turning movements of the gun and consolidates the system. The brake gear is on the well known Canet type, with the central counter rod. The energy of the recoil is stored up, as stated above, by the compression of a series of springs;



TEN CENTIMETER AND SIXTY-FIVE MILLIMETER QUICK-FIRING CANET GUNS FOR THE GREEK NAVY.

by this means the gun is run out into firing position automatically and at all the different angles of elevation; the gun, however, can be held back after firing for as long a period as may be required. The training mechanism, both for elevation and horizontal direction, is of the ordinary type, and is under the control of one man; for the horizontal training, a pinion on the upper carriage gears into a toothed ring on the fixed base. For night firing, two small electric lamps are provided, that throw a beam on the sights; the current is furnished from a battery placed on the mounting. A hand pump is attached to the mounting; its use is to run the gun back when firing is not taking place, by operating the brake, or to hold it in position against the springs that have been compressed by the recoil. It should be mentioned that the sighting apparatus is not placed on the gun, but on the mounting, so that it is independent of all the movements of the former; this arrangement is found greatly to facilitate the use of the gun, as the sights are not deranged with each round fired.

The mounting of the 65 millimeter guns is very similar to that we have just described, but it is less elaborate; the spring compressor is placed at the side, and not on the top of the sleeve; and the horizontal gear is not introduced, the smaller weight to be moved rendering this unnecessary; a shoulder piece attached to the rear of the gun affords sufficient leverage for the man firing to train the gun without difficulty.

It will be at once seen from the foregoing description, and from the accompanying illustrations, for which we are indebted to London Engineering, that these guns and their mountings are of a very simple type; the results of the trials, however, show that nothing has been sacrificed in efficiency to secure this absence of complication. We understand that Mr. Canet considers this type of armament to be the simplest and among the best of the very numerous designs for which he is responsible.

Ball bearing car wheels are now being used on ore cars in some of the mines on the Menominee Range. They are the invention of John T. Jones, and are manufactured by D. Clint Prescott, of the Marinette Iron Works, Marinette, Wis. It is stated that one man can easily push a car which would require three or four men if fitted with the usual wheel and bearing. It is the intention of the patentee to also apply his invention to heavy freight and passenger cars.

THE POTOSI, THE LARGEST SAILING VESSEL IN THE WORLD.

THE accompanying illustration shows the German five-master Potosi, which is the largest sailing ship in the world. She is owned by Mr. F. Laeisz, of Hamburg, and was launched from the shipyard of Joh. C. Tecklenborg, Geestemunde, Germany, on June 8, 1895. Her dimensions are: Length over all, 394 ft.; between perpendiculars, 365 ft.; width over the plating amidships, 49 ft. 9 in.; depth from upper edge of keel to under the main deck amidships, 31 ft. 2½ in. Her register tonnage is 4,027 tons gross and 3,854 tons net; carrying capacity, 6,150 tons; displacement on an average draught of 25 ft., 8,580 tons. This colossal sailing ship, says the Steamship, is built of Siemens-Martin steel, in accordance with the regulations of the Bureau Veritas and the British Lloyd's for the highest class, and under special survey of those institutions, and with extra stiffening and strengthening arrangements, in view of the heavy masting and the enormous pressure of the sails.

Two steel decks run over the whole length of the vessel, the upper one being sheathed with yellow pine; and there is also another deck in the fore peak and the bridge deck, also of steel, covered with wood. The structures above the main deck comprise a short poop deck, under which is placed the steering apparatus, a bridge house, 70 ft. long, containing accommodation for a crew of about 44 men, a passenger cabin, the cook's galley, provision store, hospital, and a spacious sailroom; there is also a forecastle, under which is located the windlass, and which provides storage spaces for lamps, oil, paint, and boatswain's stores.

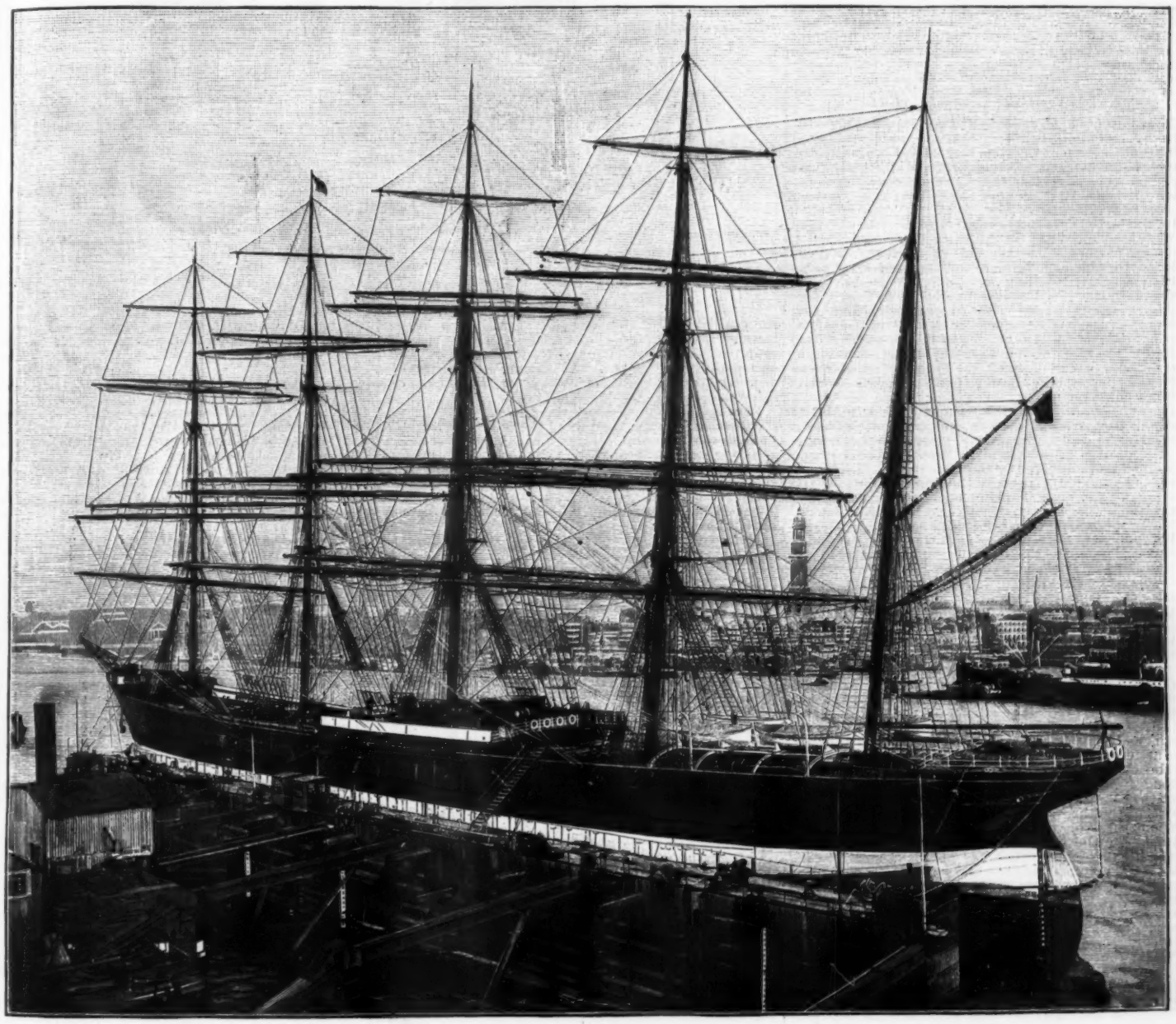
The steering of the ship is effected by means of an apparatus placed on the bridge deck, and furnished with a pair of teak hand wheels connected with the steering gear under the poop deck by means of a galvanized steel wire rope. The rudder itself consists of a frame of cast steel, into which a steel plate is riveted and the pintles are inserted. Besides the large capstan for raising the anchors (the latter weighing about 3 tons), there are two others on the main deck, besides 13 different winches for working the sails and loading and unloading cargo. She carries four boats, all of which are large patent iron lifeboats.

The Potosi is rigged as a five-masted bark, with double topsail and topgallant yards. The masts and yards are of steel, the height of the mainmast from keel to truck being 210 ft., and its diameter at the deck 34 in. All the standing tackle is of galvanized iron and the running gear partly of wire and partly of hemp. The spread of canvas, with all sail set, is equal to about 5,000 square yards.

The Potosi, which is commanded by Capt. Hilgendorf, has proved a very fast ship. After sailing from Geestemunde on July 25, 1895, she made the outward passage to Iquique, Peru, in 72 days, and the homeward trip to Hamburg in 71 days, thus taking 5 months and 2 days for the round voyage. Leaving Hamburg on March 8, 1896, for her second trip to Iquique, she left that port again on June 3, and arrived in Hamburg on August 22, with a full cargo.

The Potosi was designed and the work was carried through by Mr. Georg W. Claussen, Jr., who is chief of the technical department. Mr. Claussen gained his shipbuilding experience on the Clyde, some twenty-five years ago.

Our illustration is taken from Ueber Land und Meer.



THE POTOSI, THE LARGEST SHIP AFLOAT.

Length, 394 feet; beam, 49 feet 9 inches; depth, 31 feet 2½ inches; draught, 25 feet; displacement, 8,580 tons.

EFFICIENCY OF TRIPLE SCREWS.

A CORRESPONDENT of the Glasgow Herald gives details regarding the maneuvering power and economy of triple screws made by a German cruiser. First, as to turning, trials were made at 12 knots speed. With three engines going ahead the turning diameter was 2,395 ft., with the two side engines 2,778 ft., and with the middle engine only 2,181 ft., so that the effect of triple as against twin screws is satisfactory. To ascertain the quickest turning circle it was found that with the outer and middle screw going ahead and the inner screw astern, all at the same number of revolutions per minute, the turning diameter was 2,034 ft. at 12 knots speed, and 2,165 ft. at 18 knots. With one side and the middle engine in operation a helm angle of about 8 deg. is sufficient to insure a straight course, and with one side engine running alone about 6 deg.

Under ordinary circumstances the ship answers her helm about five seconds after it is set, and the heel of the ship with the helm well over is seldom more than 2 deg. at full speed (21 knots) and one deg. at half speed, but at full speed the helm angles of 10 to 12 deg. reduce the speed between one and two knots. Steaming at 18 knots, the vessel stops in 1¼ minutes after all engines are put full power astern, the distance covered in the interval being 1,310 ft.; at 11 knots the time is 55 seconds and the distance 490 ft. The vessel in question, the Kaiserin Augusta, is of 5,681 tons displacement. The full power was 13,425, which gave a speed of 21½ knots, and the coal consumption was at the rate of 2·06 lb. per indicated horse power per hour,

being reduced to 1·88 lb. when the boilers were less forced, the power then being 11,270, and the speed of the ship 20·47 knots. With the three engines running at three-fifths power the indicators showed 6,875 indicated horse power, with a consumption of 1·746 lb. per indicated horse power per hour, while with two engines developing about the same power the consumption was 1·780 lb. The test of greatest interest, however, was at one-fifth power, sufficient to get "service speed," for it is assumed that with two engines it is difficult to get the same economy at such low power as with one engine. The trial at one-fifth power was of 24 hours' duration, the stokehold pressure being 0·47 in. With the two side engines running the power was 2,340 indicated horse power, and to keep it down to this the revolutions were 76·25, while the coal consumption was at the rate of 2·025 lb. per horse power per hour. With the middle engine working the power was 2,305 indicated horse power, the engines making 90·5 revolutions, while the coal consumption was reduced to 1·927 lb. The speed, however, was about half a knot greater, but this may have been due to the drag of the two propellers, which, although they were uncoupled, were only running 50 against the 90 revolutions of the middle screw. The gain of the three-engine arrangement is therefore only about 240 lb. of coal in the hour, or about 2½ tons per day. Where the power is not excessive—i. e., over 30,000 indicated horse power—there seems little gain, although the multiplication of engines reduces the chances of disablement by accident or shot; but there is also the multiplication of men to tend and of expense to keep in repair the larger number of parts of mechanism.

SOME NEW HORSELESS CARRIAGES.

IN an interesting lecture delivered a few days ago before the Automobile Club, of France, Mr. Collin called attention to the fact that the builders of horseless carriages have made a twofold progress during the last eighteen months, in that they have not only improved upon the types that already exist, but have devised motors that are entirely new.

In this article we propose to describe two of these new types, and shall begin with Messrs. Panhard & Levassor's Phenix, which, in the opinion of those who are capable of judging of such matters, may be regarded as nearly reaching perfection.

The old Daimler motor consisted of two cylinders placed at right angles with the carriage, and each forming an angle of 15 degrees with the vertical. The two cylinders, AA', of the Phenix are vertical and placed in the longitudinal direction of the carriage, as may be seen in Figs. 1 and 2, the former of which represents the front of a Panhard & Levassor carriage of the most recent type.

The eduction valves in the Daimler were actuated by two rods that received their to and fro motion from a wheel that moved in the grooves of one of the flanges of the crank. This system of distribution has been simplified and improved in the Phenix. The prolongation of the shaft, B, through the intermedium of the gearing, C, and in the ratio of one to two, actuates a lateral shaft, D, provided with two cams, EE', which, at the proper moment, lift the valve rods, SS'.

This lateral shaft, which extends the entire width of the motor, upon the side opposite that shown in Fig. 2, carries in front of the cams a piece, F, upon which acts the centrifugal regulator mounted upon this same shaft, D. This piece, F, is at first cylindrical and then assumes the form of a cam which is eccentric at f. When the motor exceeds the normal velocity, the regulator draws the piece, F, forward, whence it follows that a hammer, R, bearing against F, through the intermedium of a spring, r, no longer exerts any friction upon the cylindrical part, but upon the eccentric part, f. The result is that, through the play of the jointed lever, ROP, the rod, Pp, is thrust in the direction shown by the arrow. This has two distinct effects, according as it is a question of the rod, Pp, acting upon the valve rod, S, of the cylinder, A, or of the rod, P'p', acting upon the valve rod, S', of the second cylinder, A'. It must be remarked, in fact, that the joint, P, of the rod, Pp, is elongated in such a way that the thrust of the lever, ROP, is lost therein without thrusting the rod, S, which remains at rest in the recess of the piece, T'.

As for the joint, P', that has no play, and for this reason the point, p', receives the same thrust as the extremity, P', of the lever, ROP'. The effect of this is to throw the rod, S', out of the piece, T', and consequently the valve is not raised and the gas does not escape. For this reason the cylinder, A', does not operate, and the motor slows up.

When the retardation is sufficient, the cam, F, returns to its normal position, the hammer, R, slides anew over its cylindrical part, and, the rod, S', being again lifted, the cylinder, A', begins to operate again.

Progress has likewise been made as regards power. The Daimler motor gave 1,740 foot pounds (3½ horse power) with cylinders of 4⅜ inch stroke and 3 inches in diameter. Upon making the stroke 5⅛ inches, it was capable of furnishing 2,030 foot pounds (3⅝ horse power) at a velocity of 750 revolutions a minute. In the Phenix, the stroke of the pistons is 4⅜ inches and the diameter of the cylinders 3⅛ inches, and this furnishes 2,284 foot pounds (4 ¼ horse power) at a velocity of 850 revolutions a minute.

In the Phenix, as in the Daimler, the explosive mixture is prepared in a carburetor, G, of the Daimler system, to which the gasoline at 700 degrees is furnished by a pipe, i, coming from reservoir, I, suspended behind the dashboard of the carriage. Ignition is effected through platinum tubes kept incandescent by means of round wick burners surrounded by copper wire gauze, and supplied with gasoline through a tube, j, which descends from the auxiliary reservoir, J. The whole is inclosed in a copper lantern, H.

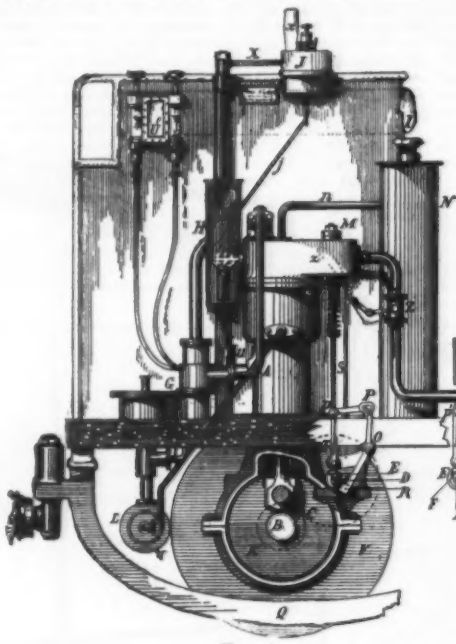


FIG. 1.

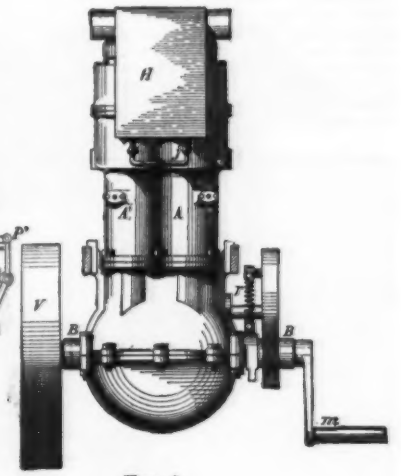


FIG. 2.

THE PHENIX MOTOR.

The down stroke of one of the pistons coincides with the descending suction curve of the other. There is but a single motive crank, the flanges, k, of which serve as a flywheel—an arrangement that assures an effective piston stroke for each revolution of the crank. The great superiority of the Phenix over the Daimler motor resides in its smaller bulk, and especially in its inferior weight—features that permit of its being more easily placed in a carriage.

The weight of the 4¼ horse power Phenix does not exceed 180 pounds, while that of the Daimler is 330. Besides, all the parts of the Phenix are perfectly accessible—a fact that is of the utmost importance in running upon public roads. This may be judged of by the following example: In order that a gasoline motor shall operate well, one of the principal conditions is that the eduction valves shall be perfectly tight. The least fouling destroys such tightness, and it then becomes necessary to clean them. In order to effect the cleaning, it is necessary in the Daimler to take off the burner lantern and to remove the burners themselves and several pieces of the piping. This work requires at least an hour. In order to remove the valves of the Phenix it suffices to unscrew the nut, M, from a stirrup bolt that holds down the covers of the valves. This operation may be easily performed in four minutes.

The cooling of the explosion chambers is effected through water set in circulation by a small centrifugal pump, L, actuated by the friction of a wheel, v, upon the rim of the flywheel, V. Motion is communicated to the mechanism of the carriage by this same flywheel, V, which is the active part of a progressive frictional gearing.

The water coming from the cylinders, A and A', through the tube, n, goes first to the condensing cylinder, N, and thence to the water reservoir, situated at the rear of the vehicle.

The lubrication of the cylinders is assured by the double lubricator, U, and two cups, u and u', that permit of the introduction of a few ounces of gasoline in order to facilitate the starting of the motor, through the winch, m.

The entire apparatus is carried by the fore frame of the carriage, in front of the dashboard, and is supported by springs that rest upon the curved axle, Q, which, at its two extremities, carries the pivots of the wheels, q and q', maneuvered by the steering lever, X, whose handle is seen at x.

A butterfly valve contained in a box, Z, upon the eduction pipe, and maneuvered by a small lever, z, on the other side of the dashboard, permits of decreasing the velocity of the motor by preventing, to a certain degree, the exit of the burned gas.

The Panhard & Levassor establishment has for a short time past been constructing Phenix motors of 6, 8 and 12 horse power. The 6 horse power motor is obtained by increasing the stroke of the pistons and the diameter of the cylinders; that of 8 horse power by employing four cylinders, and that of 12 horse power by coupling two 6 horse power motors. These latter motors differ in no respect from the type represented in Figs. 1 and 2.

We now pass to the motor of the future—the electric motor—which, it seems to us, is destined to become the type for traction in cities as soon as a primary battery shall definitely solve the problem of automobile locomotion. But we are still dependent upon the accumulator, which quickly becomes exhausted and has to be taken to the works to have its lost energy restored. Nevertheless, a great stride appears to have been made by Mr. Jeantaud, and for this reason the electric carriage that he has devised deserves a notice in this article.

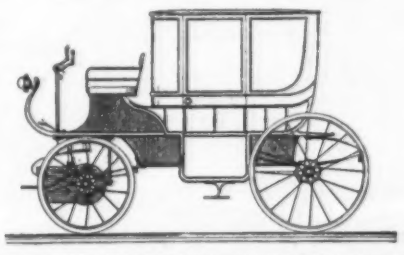


FIG. 3.—THE JEANTAUD ELECTRIC MOTOR.

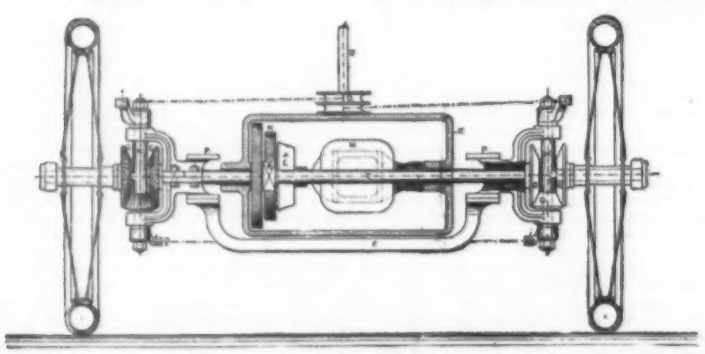
It is a carriage for four passengers and a driver. Its body is of aluminum plate and rests upon a steel frame that holds the accumulators.

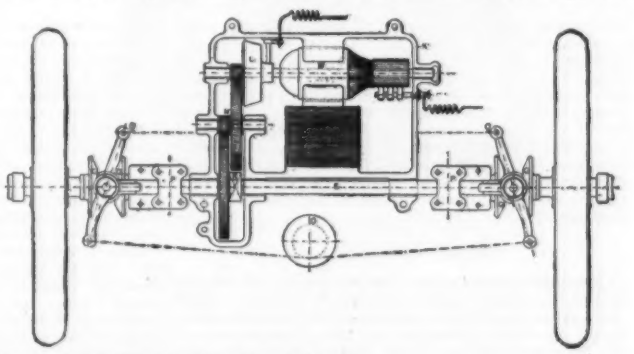
The mechanism is reduced to its simplest expression: i. e., to two trains of steel gearings immersed in oil and connected on the one hand with the motor and on the other with the front axle, which is both the driving and steering one. This is the entire mechanical part of the carriage.

These different arrangements have permitted of making a relatively light vehicle, since, in running order, it weighs but about 2,200 pounds.

The accumulators are of the Omega type and have a capacity of about 15 ampere hours to the pound. This great capacity, which has never before been realized, is due to the constant efforts of Mr. Brault.

This new electric carriage will be able to make a trip of sixty miles on a level, and of thirty-six upon a varia-





FIGS. 4 AND 5.—THE DRIVING AND STEERING AXLE OF THE JEANTAUD MOTOR.

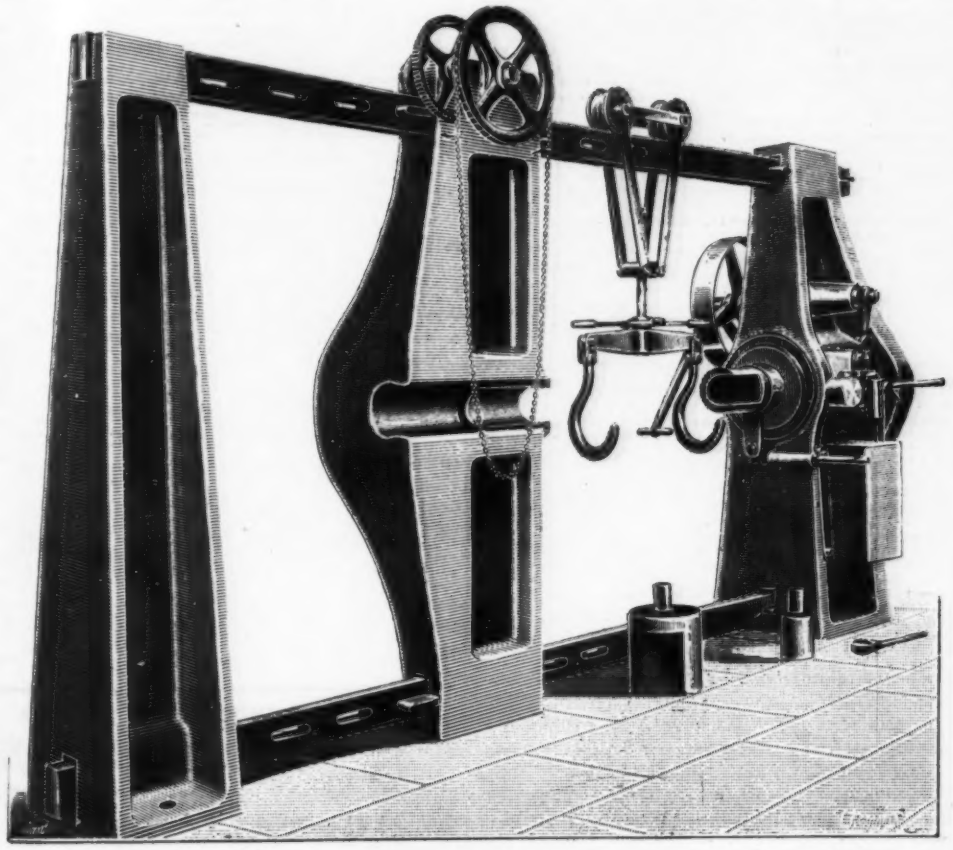
A, accumulators; B, motor; C, brake acting automatically upon the front and hind wheels; D, steering bar; E, motive and steering axle; F, false axle; G, transmitting wheels and pinion; H, steering pivots; I, ball bearings; K, box containing the motor; L, magnetic starting gear; M, motor; N, reducing train; O, steering pulleys; P, spring supports; Q, steering rod; R, differential gear.

ble roadway, without taking on a new charge. It is said that the changing of the speed, applying the brake, and stoppage will be effected through a simple handle passing over a dial, as large as that of an ordinary telegraph, placed upon the handle bar. The breaking of the current and the passage from one point to another are effected at a very slight intensity, say of five or six amperes, owing to a new arrangement, instead of a hundred amperes, a current often approached in the propulsion of carriages upon the road, and which necessitates heavy, bulky and but slightly resistant apparatus.

For our illustrations and descriptions we are indebted to L'Illustration.

WHEEL PRESS.

WE illustrate below the fine hydraulic wheel press for inserting axles, by Messrs. Fairbairn, Naylor & McPherson. The cut is self-explanatory. It will be seen that the large vertical transom can be moved to various positions to suit a variety of work, and thus the stroke of the pump is kept short, and great stiffness is gained. The loose heads of the piston rod, of which several sizes are provided, are made of the shape figured to clear the end of the axle as it comes through the boss of the wheel. The shackle for carrying the axle is allowed longitudinal movement on the top beam of the frame, and can be raised vertically by means of the screw and capstan handles shown. The manager of the Northeastern Locomotive Works, at Gateshead, speaks in terms of the highest appreciation of this machine.



HYDRAULIC WHEEL PRESS.

We are indebted to the Engineer, of London, for the cut and particulars.

REPORTS ON ENGINE TRIALS OF 1896.

LE REVUE UNIVERSELLE DES MINES DE LIÉGE published in its issue of 1896, volume XXXIV, an account of the work of the Experimental Engineering Laboratory of Prof. Dwelshauvers-Dery in the early part of the past year. The following is a brief abstract of this series of reports:

These experiments were conducted in the operation of the experimental engine of that laboratory for the purpose mainly of ascertaining the effects of draining the steam chest, while in action, of superheating, of steam jacketing, and, further, to obtain a measure, on a large scale of operation, of the mechanical equivalent of heat energy.

The latter, the most interesting and important, perhaps, from a general and purely scientific point of view, are also exceedingly important as corroborating, on this large scale of work, the earlier laboratory tests of Joule, and especially of Rowland. The engine is a machine built especially as an "experimental engine," and so constructed as to permit the investigation of as many as possible of the numerous problems of steam engineering, while at the same time combining in its design the requisites for practical work of a less scientific character and permitting the instruction of students in the methods of manipulation of steam engines. The series of researches here described was made by setting the engine in operation and continuing its action until it had become "steady" in all its essential conditions of operation, then by means of the steam engine indicator ascertaining the state, the quantity and quality of the steam en route through the cylinders, and measuring the power developed en gros and net by the indicator and the Prony brake and by their comparison. A sufficiently complete description of the engine and the details of the accessory apparatus is given in the paper of which this is an abstract.

A delicate and accurate brake system permits the measurement, with great precision, of the quantity of work delivered to the strap of the brake and its comparison with the exact quantity of heat into which it is transmuted, and which is carried away by the water employed for cooling it, the weight and change of temperature of which are measurable with similarly satisfactory accuracy. The outcome of the investigation, of which the detailed computations need not be stated here, gave the value of the heat equivalent as 427·2 kilogrammes per calorie, as the mean of six experiments, or within one-tenth of one per cent. of that now accepted generally as the result of Rowland's determination under similar conditions of temperature, 426·9.

The figure 426·9, 778 foot pounds in British measures, has already come to be generally accepted by engineers in their computations relative to the heat motors, and this first exact comparison of the two energies on a large scale, and especially using the steam engine itself as the apparatus of determination, will undoubtedly settle the question of the accuracy of that figure—certainly within the limits of precision demanded by the engineer.

The steam engine has not usually been regarded as an instrument of precision, but the six trials here recorded gave the figures, the integral numbers being taken, 428, 427, 432, 438, 428, 431, a degree of regularity being thus attained which may appear surprising to one not an expert in this field of applied science. For all steam engine trials it may be assumed that henceforth the figure adopted for the Carnot heat thermodynamic equivalent will be taken as 778 foot pounds per B. T. U., 427 kilogrammes per calorie.

The investigation of the effect of drainage of the steam chest during the operation of the engine, with the object of securing perfectly dry steam at entrance into the steam cylinders, was made in a series of eight engine trials, and at the constant boiler pressure and engine power, as secured at the brake. When the drain cocks were closed, the steam entered the cylinders carrying 5 to 8 per cent. moisture; when open, the moisture ranged from 1·54 to 1·86 per cent. An effective separator at the engine would have undoubtedly had a similar effect, and the trials reported may be taken as measuring the value of that now almost invariable accessory of the high speed engine in this country. The engine delivered about fifteen horse power during the trials.

The results of these experiments showed that gain by draining the moisture from the steam before entrance, under the stated conditions, into the cylinders, amounted to the following quantities:

Steam Saturated at Entrance.—The gain, unjacketed, was 9·29 per cent.; jacketed, 12·08 per cent.

Steam Superheated.—A loss was experienced by drainage of 5·33 per cent., unjacketed; 1·34 per cent. jacketed.

Engine Jacketed, Economies.—With saturated steam, the economy obtained by jacket action, without drainage, was 26·47 per cent.; with drainage, 28·73 per cent.

With steam superheated, without drainage, the gain was 25·02 per cent.; with drainage, 27·86 per cent.

Steam Superheated.—With steam superheated 4° C., the gain obtained amounted to 21·7 per cent. without jacketing and without drainage, 9·07 per cent. with drainage; with jacketing it amounted to 20·16 per cent. without drainage, 9·07 with drainage. With jackets in operation and without drainage, the gain by superheating was 20·16 per cent., and with drainage, 7·7 per cent.

It thus appears that separation of the moisture from the entering steam is found to be an important matter; with superheated steam any drainage is obviously, as here shown by direct experiment, wasteful.—Science.

ALCOHOL FROM BEET MOLASSES.

IT has frequently been urged in these pages that the residuum molasses from a beet sugar factory find one of the many utilizations to which it can be put. The use of this valuable product as a fertilizer may render certain services, but this practice should be encouraged only as a last resort. It has been pointed out that molasses, combined with fodder, could render excellent services for cattle feeding, etc. When European manufacturers learn of the difficulty in disposing of beet molasses in the United States, they assert that the entire question of beet sugar making from a scientific standpoint cannot have been thoroughly understood by American capitalists. During the early history of the Alvarado factory, in California, the beet molasses was thrown away, and after the introduction of the Steffen process, at Watsonville and Chino, the residuum from a sugar standpoint has no longer the same importance. The objections to the process, or to any other based upon the combination of lime with sugar, are numerous, and cannot, for the present, be discussed, it sufficing to say that even by this process there remains a residuum containing the salts taken from the soil by the beets in growing. Just whether it is better to use this final product as a fertilizer or for other purposes is to be determined by the conditions of the special environment of the factory. In the remarks that follow herewith details will be given of the best way of distilling alcohol from beet molasses, and also the utilization of the final vinasse. The hints given agree with those of the two experts already referred to.

The entire question of molasses utilization has assumed a new aspect within the past few years, due partly to special fiscal laws in France, Germany, etc.; in some cases to the distiller's advantage, and then again in direct opposition to it. One fact is certain—the process known as osmosis has almost entirely disappeared from beet sugar factories. The molasses distiller purchases the product that is most to his advantage, and the residuum from sugar refineries is always richer in those elements that enter rapidly into fermentation than is molasses from a beet sugar factory, owing to a certain percentage of glucose which it contains, due to the fact that sugar refineries use both cane and beet sugar. The refiner's molasses, consequently, brings a higher price in the market than beet molasses. However, in dealing with this residuum one is often misled if too much dependence is placed upon the polariscope. The true and only basis for purchase is to determine the quantity of alcohol generated by fermenting a sample of the molasses offered for sale; the percentage of salts is thus also made known; since the latter have a commercial value, they must be considered. The average composition of beet molasses in France, according to official analysis, is as follows:

	Minimum.	Maximum.
	Per cent.	Per cent.
Crystallizable sugar.	44	46
Glucose	traces	traces
Salts	10	12
Water	15	19
Organic substances	22	28

From these figures it is possible to assert that about 3·18 gallons of alcohol at 100° can be obtained from 100 lb. of molasses. The practical yield is somewhat higher, and under ordinary circumstances at least 3·6 gallons may be reached. Here is a case where theory and practice do not agree; the percentage of salts shown in analysis permits one to determine only approximately the practical yield of potassa; however, the latter may be estimated exactly. The organic substances are complex, and must remain unknown quantities. In this writing we cannot enter into the question from an intricate chemical standpoint, as it would carry us beyond the scope of this journal. In the case of utilizing beet molasses for alcohol production, sulphuric acid must be added, its purpose being not exactly the same as in the beet distillery. In those operations of beet sugar extraction where lime is used the final residuum molasses continues to retain in its composition sufficient of that calcic alkalinity to prevent the nitrates from decomposing and at the same time maintain the organic substances in that condition which is favorable for butyric acid fermentation, but where sulphuric acid is added in sufficient quantities there follow certain chemical changes, and there should be a final acidity corresponding to 2·5 to 3 grammes per liter. Or for 100 lb. molasses there would be 6·8 lb. carbonate of potassa. There seems to be considerable difference of opinion as regards the action of sulphuric acid upon beet molasses, some experts maintaining that it remains in a free state, M. Barbet, by a simple chemical argument, based on true scientific principles, demonstrates that this acid acts on the organic acids and upon those volatile fatty acids that offer so much difficulty to fermentation.

Preparation of the Wort.—When molasses is considered from a practical standpoint, it may be admitted that it is simply an impure sugar solution, and the addition of water would soon cause a condition permitting rapid fermentation: this dilution should be so that it would have a density corresponding to 8 to 10° B., or about one pound of sugar per gallon of the solution. It would not be desirable to allow a wort of this kind to ferment, as the operation would be most difficult to keep under control, and certain impurities must be got rid of, the process being known as denitrification. The molasses is pumped into a tank generally placed on the upper floor of the distillery and then diluted with hot water to which has been added a known quantity of sulphuric acid so as to be at 30° B.

The vat should have a steam coil at the bottom, and above a suitable flue to carry off the gases generated. The whole is heated to boiling point for fifteen minutes, during which period the gases are driven off. The watery vapor produced during boiling carries with it those volatile acids detrimental to fermentation and also certain quantities of ammonia, which, if allowed

to remain, would frequently impart a disagreeable odor to the alcohol in the distilling columns. With the view of preventing any caramelization, it is found desirable to inject steam into the mass of boiling liquid. The air introduced at the same time with the steam will, in a measure, prevent this difficulty, and will, furthermore, act mechanically in carrying with it the volatile substance, under which circumstances the diluted molasses need not be heated beyond 200° F.

It is of no possible importance whether the entire sucrose contained in the molasses solution is converted or not into glucose, even after a continued boiling. The essential is that there be even a partial inversion, under which circumstances the fermentation can commence, as it progresses all the remaining sugar will certainly be transformed into carbonic acid and alcohol. The real object of the denitrification is to get rid of those impurities that are antiseptics and which either retard or prevent entirely fermentation. The methods for denitrification are numerous, some of them being more economical than others, as well as the methods of heating, and efforts made at utilizing wasted caloric of one operation to complete the work of another. One of the best arranged methods, and at the same time most economical, is the Barbet continuous process for denitrification of molasses. The apparatus is entirely of copper, and has considerable height and is divided by partitions arranged lengthwise which force the molasses to travel considerable distance before leaving the apparatus. After the molasses has been sufficiently diluted in special vats placed at an upper elevation, it passes through the tubes of a recuperator, in which apparatus it is heated at the same time as the hot juice from the denitrificator is being cooled during its passage around exterior of said tubes. It is claimed that by this apparatus the dilution of the molasses can be pushed to almost the condition of wort, obtaining at the same time a liquid that is completely sterilized without any increased cost for fuel.

Fermentation of Beet Molasses.—Whatever be the method for denitrification, the molasses is received in special vats where it cools to the desired temperature and is diluted to a density determined for the wort; after this cooling the product is run into the fermenting vats. The method for starting fermentation of diluted molasses is just the same as with beet juices (but owing to the absence of certain nitric elements the continuous fermentation cannot be managed without great care), that is, single vat fermentation with an additional amount of peptone added to the sterilized wort in which will develop the ferment cells. In France the worts have generally a density corresponding to 8 to 10° B., which corresponds to about 2 lb. of molasses per gallon of wort sent to the vats.

Respecting this quantity of molasses, it is interesting to note that with a proper ferment and a thorough knowledge of the question, it is possible to ferment a wort containing 2·7 lb. molasses per gallon of dilution. The cost of a fermentation under such circumstances would not be financially profitable with the ferment purchased, but may be a practical success by the use of ferments prepared by special appliances in the distillery proper. As beet molasses is a final residuum from the beet sugar factory, it contains considerable lime, which during fermentation combines with the free sulphuric acid and falls to the bottom of the fermenting vats. It is not in most cases desirable to send this sulphate into the distilling column, as it would soon clog it; hence, the reason why decanting vats for the fermented wort are desirable. This deposit with the residuum water from washing fermenting vats can be used as a fertilizer.

As before mentioned, the beet molasses distiller is at the mercy of the fiscal laws. In some countries it is urgent to ferment rapidly, and certain distillers in such cases will use nearly 7,000 lb. of ferment for twenty tons of molasses worked in twenty-four hours. The deposit from lime and exhausted yeast cells is so voluminous that decanting is no longer possible, and hence the fermented wort with deposits is run through filter presses, the filtrate being subsequently run into the distilling column. Respecting this filtration, it is important to note that considerable pressure is needed, as the fermented wort would not pass through the filtering cotton cloths. The deposits must be subsequently washed in the presses, otherwise there would be a considerable loss of alcohol. We shall not refer, for the present, to other methods of denitrification.

Quantity of Sulphuric Acid Necessary for Denitrification and Fermentation.—As the composition of molasses varies, the quantity of acid needed for denitrification and fermentation must also vary. From a practical standpoint, there should be added from 1 to 1·5 lb. sulphuric acid [SO_4H_2] per 100 lb. molasses, which, when supposing 2 lb. molasses per gallon of wort, means an acidity per liter of 2·75 to 3·75 grammes.* M. Barbet says that guesswork in a distillery is a mistake; he recommends a careful chemical method that must be worked by the chemist in the laboratory, but we shall not enter, for the present, at least, into the details of this closer manipulation.

There are practical methods for ascertaining approximately the quantity of sulphuric acid needed in order to secure the best results. One must look into the acidity before and after fermentation of the wort. The increase of acidity should not be greater than 0·2 gramme to 0·3 gramme per liter, and fermentation, while being active, should be kept under control and last about forty-eight hours, by decreasing the temperature or acid used. Microbes of many kinds are to be dreaded, and should be kept under control until the yeast cells do their work, made evident by the generation of carbonic acid, etc., over the vats. If the acid has been used too sparingly, or the temperature is too high, there results a strange odor, not unlike rubber, which offers difficulties to overcome during rectification, and should never be allowed to exist in the fermented wort or low wines. A final, practical fact to remember is that the acidity of fermenting liquor should be increased if the first alcohols leaving the rectifying column are alkaline, in which case the rectified alcohol obtained has a fishy smell, which is certainly not desirable when considered from a commercial or any other point of view.—The Sugar Beet.

* Here and in all preceding writings grammes and liters are used only when chemical analysis is referred to and interests laboratory work.—ED.

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